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SEASONAL PATTERNS IN THE EPIGAMIC DISPLAYS OF SOME SURFACE-FEEDING DUCKS

BY A. OGDEN RAMSAY

THE elaborate epigamic display of the Mallard Duck (*Anas platyrhynchos*) and related species of the Anatinae, has been studied intensively by Lorenz (1941, translated by C. H. D. Clarke and published, 1951–53) and by Delacour and Mayr (1945). The following observations describe the frequency of display during the year. These observations were made on birds maintained in the J. Rulon Miller Wildlife Refuge, McDonogh School, Maryland. This refuge consists of a spring-fed pond 150 × 250 feet in area and 18 inches deep and is surrounded by a six-foot fence erected approximately 30 feet from the pond. Most of the ducks present are pinioned. The hand-reared, full-winged Mallards, Black Ducks (*Anas rubripes*) and Wood Ducks (*Aix sponsa*) do not migrate, but Pintails (*Anas acuta*) and Shovellers (*Anas clypeata*) are apt to disappear in the course of the spring migration.

The birds were observed for one-hour intervals from 7:30 a.m. to 8:30 a.m. from the middle of September, 1952, to the middle of April, 1953. Observation periods of one-half hour also were kept in the spring of 1952. The data obtained were the number of displays of various types per bird per hour. The distribution of these frequencies was by no means normal and hence averages were not suitable. After trying several technics, it seemed that the most appropriate measure was the percentage of days on which there were more than five displays per hour. The tables give these percentages and indicate the significance of particular differences. It is recognized that this test is not very sensitive. I would like to express my appreciation to Mr. E. Carey Kenney for drawing the frontispiece, and to F. K. Hilton for drawing the graph. Dr. David E. Davis is responsible for the statistical analysis of the data.

TYPES OF DISPLAYS

All of the species of surface feeding ducks show homologous movements in display. The most readily observed movements of the Mallard are shown in the frontispiece. These will be described briefly. Much more detailed descriptions have been made by Lorenz (1951–53) and by Delacour and Mayr (1945). In the following report the terminology followed will be that of Lorenz as translated by Clarke.

Preliminary head shake.—In the Mallard (Lorenz, 1951:164–182) and the Black Duck the males assemble in groups for social display. As excitement mounts, the feathers of the head become ruffled and the head is sunk on the body and shaken repeatedly. Then, if tension increases, one or more

drakes rear up high out of the water and flick the head forward. If tension continues to increase, this will be followed by one of the three forms of display mentioned below. Simultaneous performance of the same movement by all members of a group has never been observed.

Grunt whistle.—The bird rears high out of the water with its head arched forward. As it rises it rakes its bill through the water. Then the bill is pressed to the breast and the bird sinks slowly back to the water. This display is accompanied by a characteristic courtship call which is distinctive for each species.

Head-up tail-up.—The head is thrown back in an arched position and then jerked abruptly upward and turned toward the female. The tail feathers are erected vertically and spread. The wing coverts are lifted: this exposes the speculum. In the Mallard this movement is invariably followed by the nod-swim. In the Black Duck the nod-swim does not always follow. Otherwise the display of the two species is the same.

Down-up movement.—". . . the drake thrusts his bill into the water as quick as lightning, and in the next movement jerks his head alone without lifting his breast, which is still low in the water. At the instant when the head is highest and the breast is deepest, there follows the whistle, just when there is greatest tension on the windpipe. In raising the bill a little fountain of water is often raised by the quick bill movement . . ." (Lorenz, 1951: 179). This movement is vestigial in the Gadwall (*Chaulelasmus streperus*) and absent in the Green-winged Teal (*Anas carolinensis*) and Pintail.

Nod-swim.—This is performed by both the male and female Mallard and Black Duck but is absent in the other species observed. The neck of the bird is stretched forward and it swims rapidly in a circle around the mate

TABLE 1

SOCIAL DISPLAYS OF 10 FEMALE MALLARDS DURING 1952-53

Values given are the percentage of days on which there were more than 0.2 displays per hour

Month	Days	Nod-Swim	Incite	Copulate	Nest Inspect.
September	17	18	12	0	0
October	31	13	29[1]	0	3
November	30	0[2]	7[1]	0	7
December	29	3	3	0	0
January	30	0	17[1]	13[1]	23[1]
February	28	0	7	28[2]	21
March	29	0	0	0	7
April	10	0	0	0	0

[1]This percentage is significantly different from the first preceding month's percentage at the 5 per cent confidence level.
[2]This percentage is significantly different from the second preceding month's percentage at the 5 per cent confidence level.

with the bill just clearing the water. In the males this movement appears as a post-copulatory display as well as in courtship movements.

Inciting.—The female follows her mate or intended mate; meanwhile she arches her neck and head toward the water and moves her head back and forth from the front to the side away from her mate and directed toward other males or rivals. It may be accompanied by short dashes of attack toward the rival. The females of all species incite.

Precopulatory display or "pumping."—". . . the precopulation display in both sexes consists of a bobbing up and down of the head, the bill touching the water at its lower course and always remaining nearly horizontal. Finally the female flattens herself, extends her neck and is mounted by the male." (Delacour and Mayr, 1945:18).

Mock preening.—This display is difficult to observe (Lorenz, 1951:72–73) and was not included in this study.

Variations in Social Displays by Months

Females.—Seasonal activities of the female Mallard are shown in Table 1. During the observations there were 10 females present. It was possible to record the activities of all the females fairly accurately, and the total was divided by 10 to give the activity per female per hour. It will be noted that inciting predominates in the female in the fall and winter. The descriptions of Lorenz (1951:167) and Delacour and Mayr (1945:18), suggest that inciting is connected with the establishment of the bond between the sexes. The female by this display announces her chosen sex partner and threatens any other male that may approach her. The female by this display also incites her mate to defend her from other males.

The females also do a great deal of nod-swimming in the fall. It seems likely that this behavior in the Mallard is analogous to the "charging" display of the American Coot (*Fulica americana*), as described by Gullion (1952: 86) and is a form of threat display. A female Mallard, while inciting, often makes short direct attacks in this position at males that may approach her. Both male and female Wood Ducks adopt a similar posture in attacking sexual rivals. A somewhat similar movement is described as threat-display and is the only epigamic display described for the Ruddy Shelldrake (*Tadorna ferruginea*) by Delacour and Mayr (1945:12).

The predominance of this display in the fall would also seem to indicate that in the female Mallard, the more aggressive or masculine tendencies are highest during that season. This supposition is supported by the fact that the females show some homosexual activity at this time. A number of female Mallards have been observed to mount and to copulate with other females. The more aggressive female did not grasp at the head of the ventral

TABLE 2

THE FREQUENCY OF DISPLAYS OF MALE DUCKS BY MONTHS

Values given are the percentage of days on which there were more than 0.2 displays per hour

Month	Days	Gadwall	Green-winged Teal	Mallard	Black Duck
September	17	0	0	0	0
October	31	0	19[1]	23[1]	16[1]
November	30	3	20	17	3[1]
December	29	0	7[1]	48[1]	10
January	30	20[1]	7	47	20[2]
February	28	32	39[1]	21[1]	4[1]
March	29	14[1]	24	4[1]	0
April	11	0	18[2]	0	0

[1]This percentage is significantly different from the first preceding month's percentage at the 5 per cent confidence level.
[2]This percentage is significantly different from the second preceding month's percentage at the 5 per cent confidence level.

female in a normal fashion but pecked at her head instead. Neither did the more sexually aggressive female nod-swim afterward. Homosexual unions were recorded on September 21 and October 16, 1951, and on October 21 and November 1, 1954. Other unions were observed but were not recorded.

Females may also sometimes be observed "pumping" together. This is recognized as a prelude or invitation to copulation.

Inasmuch as Lorenz (verbal communication, November 15, 1954) stated that he had never observed homosexual behavior in Mallards, it seems clear that the presence of an excess of females is the cause of this abnormality. We keep an excess of females in the refuge as a means of reducing the excessive sexual activity associated with captivity.

In the fall of 1954, for the first time, females laid a total of 28 eggs. Though they copulated in a normal fashion during this period (observed 17 times) none of the eggs was fertile. Females also show some interest in nesting sites in the fall, darting in and out of the nest boxes provided for them. The males show some definite but slight interest in nest sites in January, February and March.

In 1953 we experienced a warm, early spring; egg-laying started on February 13 and incubation on March 19. In 1955 egg-laying did not start until February 24 and the ducks dropped their eggs on the ice prior to its thawing.

Males.—Seasonal occurrence of epigamic display of males of several species of surface-feeding ducks is shown in Table 2 and Figure 1. This figure is based on data obtained by daily observations from mid-September, 1952, to mid-April, 1953. A separate data sheet was kept for each day and all forms of display were recorded. There were five male Mallards, two male Black

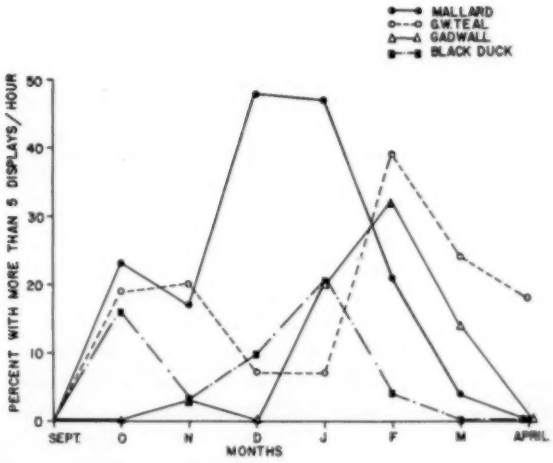

FIG. 1. The frequencies of displays by males in various months.

Ducks, one male Pintail, one male Green-winged Teal, and one male Gadwall under observation at this time. If two males of the same species were displaying, the display of both was recorded and then the total divided by two. If several males of a species were displaying, efforts were made to follow one male. It will be noticed that the several species have different periods of maximum display. The male Mallards started displaying in the fall and then reached a high level of intensity in December; the Black Duck had an autumn peak but most activity in January; the maximum for the Gadwall fell in February; the Green-winged Teal had peaks in fall and in spring.

In the male Pintail the sexual display of the male is directed at the female (Lorenz, 1952:10) and clearly seems to represent a form of sexual competition. During the spring of 1952, when there were two male Pintails present and no females, each male displayed more than five times per half-hour observation period 20 per cent of the time. In the absence of female Pintails, this display was directed at male and female Wood Ducks and one male formed a fertile union with one of these ducks. The next spring, with only one male and one female Pintail present, the male displayed more than five times per hour on only seven per cent of the days. Likewise, my solitary male Redhead (*Aythya americana*) seldom displays. When it lost its mate this male courted a female Mallard exclusively. The Green-winged Teal and Gadwall drakes display very actively in the absence of other males of their own species.

The data were considered from the viewpoint of temperature but no cor-

TABLE 3

DISPLAYS OF MALE AND FEMALE GREEN-WINGED TEAL
Values given are the percentage of days on which there were more than 0.2 displays per hour

Month	Days	MALE		FEMALE	
		Total Display	Tail-up	Total Display	Tail-up
September	17	0	0	0	0
October	31	19[1]	13	3	3
November	30	20[2]	3	3	0
December	29	7	3	0	0
January	30	23	13	7	7
February	28	43[2]	11	0	0
March	29	27	14	3	3
April	11	18[2]	9	9	9

[1]This percentage is significantly different from the first preceding month's percentage at the 5 per cent confidence level.
[2]This percentage is significantly different from the second preceding month's percentage at the 5 per cant confidence level.

relation was apparent that was not related to seasonal changes in frequency of display.

The display of the Green-winged Teal is similar to that of its European counterpart (*Anas crecca*) as described by Lorenz (1952:172–175) except for the fact that in the American species, the female responds to the preliminary shaking, grunt-whistle and head-up, tail-up displays of the male by also performing the head-up, tail-up display. Dr. Lorenz stated that he had never observed females to display in this fashion in *Anas crecca* or in any other species of waterfowl (verbal communication, Smithsonian Lecture, November 16, 1954). Meanwhile, the male and female slowly circle each other about one yard apart in a form of paired display. The males display alone as well as in the paired display but I have never observed the female to do so. The female occasionally goes through the preliminary head shaking movements (seven observations). As emphasized by Lorenz (1952:173), the male Teal displays at a very high level of intensity at the height of its courtship, 12 to 25 times in periods lasting from five to 10 minutes and separated by short rest periods. The females display at a much lower level of intensity, even when we compare homologous movement (Table 3). From Hochbaum's (1944:19–20) description it seems clear that he thinks that the display of the male Redhead and Canvasback (*Aythya valisneria*) is not competitive in the fall but that they engage in mutual or paired display in the spring.

SUMMARY

Numerical data are presented on seasonal differences in the epigamic display of several species of Anatinae.

In the female Mallard, inciting and nod-swimming predominate in the fall. These displays are concerned with the establishment of bonds between the sexes and with the establishment of territory. Females also showed some homosexual activity at this time but not after mid-November.

The periods of maximum display in the Gadwall, Mallard, Black Duck, and Green-winged Teal did not correspond. Peaks of activity were noted in the Mallard in December, the Black Duck and Green-winged Teal in January and the Gadwall in February.

Competition among males in displaying before the female was noted in the Pintail, Redhead and Gadwall, but not in the Mallard and Black Duck. A paired display was observed in the Green-winged Teal, in which the female responded to the display of the male by the head-up, tail-up display; meanwhile the male and female slowly swam about each other.

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McDonogh School, McDonogh, Maryland, June 29, 1955.

THE APPENDICULAR MYOLOGY OF THE SANDHILL CRANE, WITH COMPARATIVE REMARKS ON THE WHOOPING CRANE

BY ANDREW J. BERGER

UNTIL recently, very little had been published on the myology of the cranes. Fisher and Goodman (1955) described in detail the myology of the Whooping Crane (*Grus americana*); they also dissected one Little Brown Crane (*G. c. canadensis*). I began a myological study of the Sandhill Crane (*G. canadensis tabida*) at the suggestion of Dr. L. H. Walkinshaw, whose interest in the biology and taxonomy of the cranes is well known. For the first specimen of this subspecies, I am indebted to Dr. Wallace Grange of Babcock, Wisconsin. After the death of this captive bird, it was frozen immediately; I dissected it during the month of April, 1955. During February, 1956, two additional frozen specimens became available. These birds were killed by hunters during the latter part of October, 1955, in Jasper County, Indiana. For these specimens, I am indebted to Dr. Charles Kirkpatrick of Purdue University and to Russell Mumford of the University of Michigan.

Through the generosity of Dr. Fisher, I was permitted to study the Whooping Crane manuscript before I began my first dissection. After I had completed this work, Dr. Fisher and I discussed differences in interpretation of certain muscle complexes. These differences will be explained in the descriptions of the individual muscles, inasmuch as it was too late to make changes in the Whooping Crane manuscript.

There are two sets of muscle terminology currently in use in this country, that of Hudson (1937) and Hudson and Lanzillotti (1955) and that of Fisher (1946) and Fisher and Goodman (1955); I have included both sets of names. The muscles are discussed in the sequence used by Fisher and Goodman; they accepted Montagna's (1945) conclusions on the numbering of the hand digits, and, consequently, proposed new names for certain muscles (1955:39).

Myology of the Wing

M. tensor patagii longus (propatagialis longus)

Fisher and Goodman (1955:43) interpret the "elongately triangular belly" arising from the dorsal end of the furculum as belonging solely to M. tensor patagii brevis and state (p. 42) that "the only muscular origin" of the tensor patagii longus is that which "comes from the antero-palmar surface of M. biceps . . . ." In view of the traditional treatment of this complex by the British and German ornithologists, I believe that it is misleading to consider the slip from M. biceps brachii as M. tensor patagii longus (Fisher and Goodman, 1955: Fig. 17). Fürbringer and Gadow believed that both the tensor patagii longus and the tensor patagii brevis muscles were derivatives of M. deltoideus major; no one, to my knowledge, has suggested that either is a derivative of M. biceps brachii. In many birds (e.g., the cuckoos), the two tensors have a common origin and the bellies are separate only distally. In some birds, the two muscles are separate throughout.

Thus, there are two possible interpretations of this complex in the cranes. I prefer to interpret the belly arising from the furculum to be the fused bellies of Mm. tensores patagii longus et brevis (see also Mitchell, 1901: 641, "deltoides patagialis"). If one does not agree with this interpretation, then it is true, as Fisher and Goodman stated, that the only muscular origin for the tensor patagii longus is that derived from M. biceps brachii. This is, in part, an academic question, but it is important that the taxonomist recognize such differences of interpretation in myological studies so that these are not given erroneous taxonomic significance.

What Fisher and Goodman call the belly of M. tensor patagii longus is actually the *biceps slip*, a muscular slip widely used in taxonomic diagnoses. The biceps slip of Beddard is the *biceps propatagialis* of Gadow and Selenka (1891:255) and the *tensor accessorius* of Parker and Haswell (1947:441), Young (1950:427), and others.

In the Sandhill Crane, the origin of M. tensor patagii longus is essentially the same as that described for the Whooping Crane by Fisher and Goodman. The fleshy biceps slip (6-7 cm. long) arises from the coracoidal tendon of M. biceps brachii, becomes tendinous, and inserts on the elastic part of the tensor patagii longus tendon. A second origin is a small tendon, attached to the deltoid crest, which contributes to the tendons of insertion of both the tensor patagii longus and the tensor patagii brevis muscles. M. pectoralis, pars propatagialis, is a wide (2 cm.) aponeurosis, which is a continuation of the superficial layer of the fascial envelope which surrounds the insertion of M. pectoralis. This aponeurosis fuses with the distal end of the belly of the tensor patagii brevis and gives rise to parts of the tendons both of the tensor patagii longus and brevis.

The main area of insertion of the tensor patagii longus is on the extensor process of the carpometacarpus, but slips extend into the manus to fuse with its fascia and with the bases of the alula quills and their coverts. Fisher and Goodman (1955:68) stated that in the Whooping Crane, a part of M. abductor alae digiti II (= abductor pollicis) arises from the inserting tendon of M. tensor patagii longus. This is not true in the Sandhill Crane. I found no branches of the longus tendon extending to the elbow; such branches were found in *G. americana*, but not in *G. c. canadensis*, by Fisher and Goodman.

M. TENSOR PATAGII BREVIS (propatagialis brevis)

This muscle is weakly developed, having a belly about 9 cm. long and 2 cm. wide; the belly extends to the middle of the deltoid crest. It arises primarily from the dorsal end of the furculum, but has a small attachment to the acromion process of the scapula. Its main tendon is reinforced, as described above, by tendinous slips arising from the deltoid crest and from pars propatagialis of M. pectoralis.

The main tendon of insertion passes distad toward the elbow and expands into a thin band (2 cm. wide), which fuses, in part, with the tendon of origin of pars anconalis of M. extensor metacarpi radialis, and then passes proximad to attach to the distal end of the humerus, adjacent to the origin of pars anconalis. The rest of the brevis tendon (1 cm. wide) passes posteriad over the forearm muscles and extends the entire length of the forearm, sending slips to the bases of the feathers; distally, it attaches to the os ulnare. Fisher and Goodman (1955:43) state that in *G. c. canadensis* "the wide tendon continues posteriorly over the surface of the wing to insert on the tendon of origin of the wide anterior and superficial part [= M. flexor digitorum sublimus] of M. flex. carpi ulnaris." The tendon does not do so in *G. c. tabida* and it is difficult for me to see how the brevis tendon, located on the dorsal surface of the forearm, could pass posteroventrad through the secondaries and their coverts to insert on Mm. flexor digitorum sublimus or flexor carpi ulnaris, which are located on the posteroventral surface of the forearm.

Fisher and Goodman (1955:43) noted that in one specimen of the Whooping Crane "M. tens. pat. brevis . . . has a divided tendon of insertion; in the other birds the tendon is single." Unilaterally in one of my specimens of *G. c. tabida*, the tendon has three strong components connected by weak fascia. The most proximal of the three components, in part, passes proximad to insert on the lateral epicondyle (ectepicondylar process) of the humerus (without being connected with the tendon of M. extensor metacarpi radialis) and, in part, fuses with the middle band. The latter expands into a broad aponeurotic sheet, which passes posteriorly over Mm. extensor digitorum communis and flexor metacarpi radialis, and has attachments proximally to the tendon of M. scapulotriceps and to the lateral epicondyle (between the origins of Mm. extensor digitorum communis and extensor metacarpi radialis). This aponeurosis extends the entire length of the forearm, fuses with the antebrachial fascia, sends slips to the bases of the feathers, and attaches to the os ulnare. The most distal of the three components of the brevis tendon inserts on the tendon of pars anconalis of M. extensor metacarpi radialis, about 1 cm. proximal to the origin of its fleshy fibers.

M. PECTORALIS

In the Sandhill Crane this is a single muscle and is not divided, as in the Whooping Crane, into superficial and deep layers. Fasciculi from the deep surface of the belly, however, do insert by a broad aponeurosis on the tendon of origin of M. biceps brachii. In the Sandhill Crane, M. pectoralis arises from approximately the inferior third of the carina, from the posterior and anterolateral parts of the body of the sternum, and from nearly the entire length of the clavicle. I found no origin from the "tracheal enclosure." The muscle inserts on the ventral surface of the deltoid crest (pectoral crest of Shufeldt, 1890:70). Pars propatagialis is entirely aponeurotic; its attachments were described above (p. 283).

M. SUPRACORACOIDEUS

M. STERNOCORACOIDEUS

M. CORACOBRACHIALIS POSTERIOR

All are similar in origin and insertion to these muscles in the Whooping Crane (Fisher and Goodman, 1955:46–48).

M. LATISSIMUS DORSI

There are a few minor differences in this complex between *G. americana* and *G. canadensis tabida*. In the latter, the origin seems to be less extensive. In the Whooping Crane, pars anterior arises from (all?) the "thoracic" (= dorsal) vertebrae (Fisher and Goodman, 1955: 48). In the Sandhill Crane, it arises by an aponeurosis (anteriorly) and by fleshy fibers from the neural spines of the first four dorsal vertebrae; pars anterior is a thin fleshy band, about 5 cm. wide at its origin, and about 3 cm. wide (2 cm. in the captive bird) at midlength. Pars anterior has a fleshy insertion (5 cm. wide) on the humerus, beginning about 4 cm. distal to the junction of the deltoid crest and the articular head; this insertion is immediately posterior to the humeral attachment of M. triceps, scapular head (= M. scapulotriceps = M. triceps scapularis).

Pars posterior, in the Sandhill Crane, arises by an aponeurosis from the neural spines of the last three (Nos. 4, 5, and 6) dorsal vertebrae, from the fascia covering the anterior edge of M. extensor iliotibialis anterior (= sartorius), and by an aponeurosis attached to the anterior edge of the ilium. Pars posterior inserts on the humerus by a small, flat tendon, immediately proximal to the insertion of pars anterior, and posterior to the uppermost portion of the scapulotriceps anchor. In *G. americana* pars posterior

"attaches to the deep side of the anterior part but also inserts on the humerus beneath the fleshy insertion of the anterior portion."

Fisher and Goodman (1955:48) state that the dermal component (M. latissimus dorsi metapatagialis) may or may not be present in the Whooping Crane. I found a minute dermal component bilaterally in one specimen, unilaterally in a second specimen, but not at all in a third specimen of the Sandhill Crane.

MM. RHOMBOIDEUS SUPERFICIALIS ET PROFUNDUS

These two muscles are similar in the two cranes, but the origins and insertions are less extensive in *G. c. tabida*. M. rhomboideus superficialis arises by an aponeurosis from the first five dorsal vertebrae. Fisher and Goodman (1955:51) point out that the entire aponeurosis of origin of this muscle "is a caudal extension of the aponeurosis of M. cucullaris, hals pt.." M. rhomboideus superficialis inserts on all but the caudal 3 cm. of the scapula in the Sandhill Crane. M. rhomboideus profundus arises from the neural spines of the last cervical and the six dorsal vertebrae; it inserts on the caudal 10 cm. of the scapula.

In both cranes, an unusual feature is that M. rhomboideus profundus is larger than M. rhomboideus superficialis.

M. CORACOBRACHIALIS ANTERIOR

This is a well developed fleshy muscle (about 6 cm. long) located on the ventral aspect of the shoulder; the belly does not cover the anterior edge of the humerus. It arises mostly by fleshy fibers from the dorsal surface of the head of the coracoid, anterior to the origin of M. biceps brachii, and from the deep surface of the biceps tendon. The insertion is as described by Fisher and Goodman (1955:51).

M. DELTOIDEUS MINOR

In *G. americana*, M. deltoideus minor has a single head; in *G. c. tabida* it arises inside the triosseal canal by two heads: a ventral head from the medial process (procoracoid) of the coracoid and from the coracoclavicular membrane; a dorsal head from the ventral margin of the acromion process of the scapula. (The ventral head corresponds, in part, to a small accessory head of M. supracoracoideus present in some birds; such an accessory head, when present, however, inserts on the tendon of M. supracoracoideus.) In *G. c. tabida*, the two heads fuse and insert distal and posterior to the insertion of M. supracoracoideus; none of the fibers insert on the tendon of that muscle. As in *G. americana*, M. deltoideus minor conceals anterodorsally the tendon of M. supracoracoideus.

M. PROSCAPULOHUMERALIS (scapulohumeralis anterior)

See the descriptions of Mm. subscapularis and "proscapulohumeralis brevis."

M. SUBSCAPULARIS

The muscle that Fisher and Goodman (1955:52-53) and Fisher (1946:584) call M. proscapulohumeralis is actually the external head (pars externa) of M. subscapularis.

M. subscapularis is similar in the two cranes and, in fact, exhibits the same general structure in all genera I have dissected. In *G. c. tabida* it arises by two typical heads: pars externa and pars interna. The inserting tendon of M. serratus anterior passes between the two heads. The external head arises from an area 3 cm. long on the lateral surface of the scapula, beginning immediately caudal to the glenoid lip. The internal head, which is larger, arises from the medial surface of the scapula over an area about 5 cm. long. Insertion is on the capital groove and internal tuberosity of the humerus (as described in detail for *G. americana* by Fisher and Goodman, 1955:53).

"M. PROSCAPULOHUMERALIS BREVIS"

As Fisher and Goodman (1955: 53) state, this muscle is "very easily overlooked, for

it lies between the posterior edge of M. delt. major and the most proximal part of the scapular head of M. triceps." Furthermore, Fisher wrote (letter, May 5, 1955) that it "was not found uniformly in the Whooping Cranes." I found this muscle bilaterally in one specimen of the Sandhill Crane, unilaterally in a second, and not at all in a third. The muscle is so small and delicate, however, that it might be destroyed by shot or be so mutilated in handling a poorly preserved specimen that one might not be aware that a separate muscle was involved at all.

In the Sandhill Crane this is a minute band of fleshy fibers 3 cm. long and only about 2 mm. wide. It arises from the ventral edge of the scapula just caudal to the glenoid fossa and *anteroventral* to the origin of M. scapulotriceps. It inserts by fleshy fibers, and not by a tendon as in the Whooping Crane, on the humerus about 0.5 cm. proximal to the insertion of M. latissimus dorsi, pars posterior, and lateral to the origin of M. humerotriceps (= triceps, internal and external heads = triceps humeralis). The area of insertion is on the plane of the inferior margin of the pneumatic fossa of the humerus, but is entirely lateral to the humerotriceps muscle.

As mentioned above (p. 285), the muscle which Fisher and Goodman call M. proscapulohumeralis is actually the external head of M. subscapularis. Thus, the name M. proscapulohumeralis is available for the rudimentary muscle discussed here. In the cranes, however, this muscle does not exhibit the relationships of M. proscapulohumeralis as I have seen them in representatives of other orders. In most genera, it arises posterior to the origin of M. scapulotriceps and inserts in the pneumatic fossa of the humerus, between the internal and external heads of M. humerotriceps. No muscle in the cranes meets these specifications. However, either the origin or the insertion of a muscle may migrate phylogenetically.

Mitchell (1901:644; 1915:415) discussed the considerable variation in development of M. proscapulohumeralis in gruiform birds, though he did not investigate the genus *Grus*. He stated that this muscle inserts on the humerus "near the forked origin" of M. humerotriceps (= anconaeus humeralis), as I have seen it in other genera. He noted also that "in *Otis* it is much reduced, and is attached to the humeral anchor" of M. scapulotriceps (= anconaeus scapularis). Fürbringer (1902:547 and Figs. 258–260) also described and illustrated M. proscapulohumeralis in genera in which it does not insert in the pneumatic fossa. In *Ciconia* and *Pelecanus*, for example, the muscle inserts proximal and/or anterior to most of the origin of M. humerotriceps. It seems likely, therefore, that in the genus *Grus*, the small muscle which Fisher and Goodman call "M. proscapulohumeralis brevis" is actually M. proscapulohumeralis. Its area of origin seems to agree with the origin in other gruiform birds, but its insertion differs slightly from that previously reported.

The muscle which Fisher (1946:587) called "M. proscapulohumeralis brevis" in the Cathartidae is M. proscapulohumeralis in that group.

M. DORSALIS SCAPULAE (scapulohumeralis posterior)

This muscle is typical in origin and insertion. In *G. c. tabida* it arises from the posterior 9 cm. of the blade of the scapula. (see also M. expansor secundariorum and Fig. 1.)

M. SERRATUS POSTERIOR (serratus superficialis posterior)

In the origin of this complex there are minor differences between the Whooping Crane and the Sandhill Crane, and, in the latter, the muscle is not separated into a superficial and a deep layer. It is so divided in the Whooping Crane. In the Sandhill Crane, the main belly is rectangular in shape, being about 3 cm. long and 4.5 cm. wide at its origin, primarily from the shafts and uncinate processes of true ribs numbers 3, 4, and 5; there is some fascial origin also from rib number 6. The insertion is almost exclusively by an

aponeurosis on the ventral edge of the posterior end of the scapula. In the Whooping Crane, the superficial layer arises from "ribs 4, 5, 6, and 7 and from fascia overlying the external layer of intercostal muscles." The deep layer arises from ribs 4, 5, and 6.

I found a large dermal component (= M. serratus superficialis metapatagialis) arising primarily from the lateral surface of true ribs numbers 4 and 5 and from the intercostal fascia. The belly terminates in the metapatagium opposite the posterior margin of the humeral feather tract. From this area, a fibrous tendon continues distad along the surface of M. expansor secundariorum almost to the elbow.

M. SERRATUS PROFUNDUS

This complex is similar in the two cranes. In the Sandhill Crane it arises by fleshy fasciculi from the lateral surface, near the angle, of true ribs numbers 1, 2, and 3, and from the transverse process of the last cervical vertebra.

M. SERRATUS ANTERIOR (serratus superficialis anterior)

As is true of the preceding two muscles, there are minor differences in origin between the Whooping and Sandhill cranes. In the latter, the serratus anterior is a small muscle arising by three fleshy slips, one each from the first three true ribs and from the fascia covering the intercostal muscles. The dense aponeurosis of insertion passes upward between the two heads of M. subscapularis and inserts on the ventral edge of the scapula, beginning a short distance caudal to the glenoid lip.

M. SUBCORACOIDEUS

This muscle has a single belly in the cranes. In *G. c. tabida* it is a very small triangular-shaped muscle, 4 cm. long and 1 cm. in maximum width at its origin from the anteromedial surface of the coracoid, just dorsal to the middle of that bone. The tendons of Mm. subcoracoideus and subscapularis insert adjacent to each other on the humerus, and in one wing they fused at the insertion.

M. BICEPS BRACHII

This muscle exhibits the same relative development in the two cranes. In *G. c. tabida* the small belly (about 14 cm. long) lies in the proximal two-thirds of the arm. The tendon is ossified near the distal end of the humerus, but not at the insertions on the radius and ulna. The larger tendon inserts on the radius. The biceps slip is present (see M. tensor patagii longus).

M. DELTOIDEUS MAJOR

This muscle is similar in the two species, but the dermal component described for *G. americana* (Fisher and Goodman, 1955:57) is absent in *G. c. tabida*. In the latter, the belly of deltoideus major is about 12 cm. long and extends slightly less than half way down the humerus. The fibers of insertion are in contact posteriorly with the humeral anchor of M. scapulotriceps. The primary origin of the deltoideus major is on the dorsolateral surface of the scapula, and there is a secondary origin, by a flat aponeurosis (7 mm. wide) from the blade of the scapula as described by Fisher and Goodman for the Whooping Crane. In the Sandhill Crane, this aponeurosis is attached about 3 cm. caudal to the posterior glenoid lip and the origin of M. scapulotriceps, and dorsal to the anteriormost fibers of M. dorsalis scapulae. I did not find an os humeroscapulare and Fisher and Goodman did not mention it.

M. TRICEPS (triceps brachii)

This complex is similar in the two cranes. In *G. c. tabida* there is a strong aponeurotic connection or anchor (1.5 cm. long and 1.5 cm. wide) between the anterior surface of the scapular head (= M. scapulotriceps) and the humerus. The humeral attachment of this band begins about 3 cm. distal to the head of the humerus and lies immediately an-

terior to the insertion of pars anterior of M. latissimus dorsi. M. humerotriceps arises from the entire inferior margin of the pneumatic fossa of the humerus and is not distinctly divided into an external and an internal head. A few fasciculi arise from the bicipital crest anterior to the area of insertion of M. dorsalis scapulae. An ossified tendon forms on the ventral margin of the belly near the middle of the arm. Fleshy fibers arise almost to the level of the distal end of the humerus, but the insertion on the ulna is exclusively by a wide tendon. The tendon of insertion does not contain a sesamoid. (See discussion of M. anconaeus coracoideus.)

M. BRACHIALIS

This muscle is typical in origin, relations, and insertion.

M. EXPANSOR SECUNDARIORUM

Fisher and Goodman did not mention this muscle, but it certainly must be present and well developed in *G. americana*.

In *G. c. tabida*, M. expansor secundariorum (Fig. 1) is a well developed, roughly triangular-shaped muscle about 10 cm. long and 3 cm. wide at its base posterior to the elbow. This is a smooth muscle, which inserts primarily on the calami of secondaries numbers 17 through 23 and on the skin containing several of the distal tertials; a fibrous band, connected primarily to the humero-ulnar pulley, attaches to number 16. The belly extends over one-third the way up the arm, where fasciculi are attached to the skin forming the dorsal layer of the metapatagium. The muscle has two tendons of origin. The distal origin is by a flat tendinous band attached to the medial epicondyle of the humerus, distal to the origin of M. pronator brevis; this origin, apparently, has not been described for the cranes previously. A second tendon is formed at the apex of the belly in the metapatagium. This tendon runs proximad through that skin fold and pierces the lowermost semitendinous fibers (which function as a pulley) of M. dorsalis scapulae, about 2 cm. from the insertion of that muscle. In the axilla, the tendon bifurcates about 3 cm. proximal to the pulley. The larger, ventral branch of the tendon has its major attachment to the medial corner of the sternocoracoidal process of the sternum; the smaller, dorsal branch passes dorsomesiad to attach to the ventral edge of the scapula, near its articulation with the procoracoid. Fürbringer (1902:572) called the tendon extending from the scapula to the sternum the "sterno-coraco-scapulare internum" ligament; Newton (1896: 608) called it simply the "sterno-scapular ligament."

M. ANCONAEUS CORACOIDEUS

This muscle was first described by Fürbringer (1902:576, and earlier papers). For a recent discussion of M. anconaeus coracoideus see Berger (1956:159). In the Sandhill Crane (Fig. 1), the belly of this muscle is about 4.5 cm. long, but only about 1 mm. in maximum width. It arises by a tendon from the "scapular" tendon of M. expansor secundariorum. Distally the belly of M. anconaeus coracoideus gives rise to a second tendon, which inserts on the tendon of M. scapulotriceps near the distal end of the humerus. This is a striated muscle, as previously noted by Fürbringer. Fisher and Goodman do not mention this muscle in the Whooping Crane.

M. EXTENSOR METACARPI RADIALIS

This muscle is similar in the two cranes. In the Sandhill Crane, pars anconalis is a spindle-shaped muscle (about 6.5 cm. long), whose fleshy fibers begin about 5.5 cm. from the proximal surface of the olecranon process and about 1 cm. distal to the area where a part of the tensor patagii brevis tendon fuses with the tendon of origin of pars anconalis. Two tendons, interconnected by fascia, are present. The anterior tendon represents one tendon of insertion of M. tensor patagii brevis; the posterior tendon, the ori-

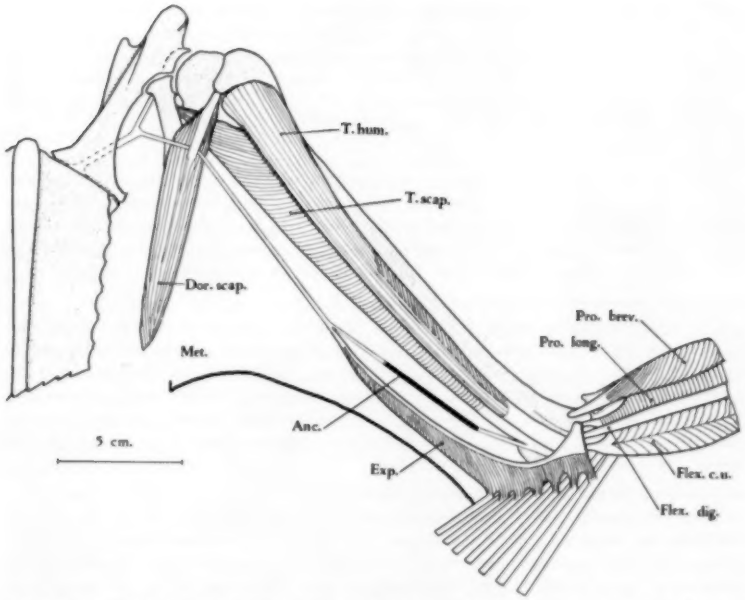

FIG. 1. Ventral view of certain muscles in the proximal region of the wing of *Grus canadensis tabida* to show relationships of Mm. expansor secundariorum and anconaeus coracoideus. The distal end of the humerus is distorted in order to show the triceps tendon and the origin of forearm muscles. Not shown is the fascial extension of the flexor digitorum sublimus tendon, which invests the superficial surface of M. flexor carpi ulnaris. Explanation of symbols: Anc., anconaeus coracoideus; Dor. scap., dorsalis scapulae; Exp., expansor secundariorum; Flex. c. u., flexor carpi ulnaris (humeroulnar pulley not shown); Flex. dig., tendon of origin of flexor digitorum sublimus; Met., metapatagium; Pro. brev., pronator brevis; Pro. long., pronator longus; T. hum., humerotriceps; T. scap., scapulotriceps.

gin of pars anconalis. Both tendons are attached to the lateral epicondyle of the humerus. Pars palmaris is developed as illustrated for the Whooping Crane by Fisher and Goodman (1955: Fig. 16). The fleshy belly is about 7.5 cm. long. Pars anconalis and pars palmaris each give rise to separate tendons, which fuse to form a single ossified tendon of insertion. In addition to the usual insertion on the extensor process of the carpometacarpus, part of the tendon fuses with the tendon of M. extensor longus digiti II (= extensor pollicis longus), as in the Whooping Crane.

M. EXTENSOR DIGITORUM COMMUNIS

In the Sandhill Crane, this is a small, spindle-shaped muscle (8-9 cm. long), which is located in a little more than the proximal third of the forearm. The tendon bifurcates near the base of the pollex. The shorter branch inserts on the posterodorsal edge of digit II (= pollex), about 0.5 cm. from the proximal end of that bone. Fisher and Goodman

(1955: Fig. 20) illustrated this branch in the Whooping Crane, but described it (p. 60) as inserting on the "third finger." In *G. c. tabida* the longer tendon is ossified and inserts on the anterobasal corner of the proximal phalanx of digit III (of Montagna and Fisher and Goodman), or digit II (of Hudson), after passing through a fibrous pulley. I found no branch inserting on metacarpal II (I) as described and illustrated for the Whooping Crane by Fisher and Goodman (1955:60 and Fig. 20).

M. SUPINATOR BREVIS (supinator)

There are no important differences between the two species in the development of this muscle. In the Sandhill Crane the belly (about 8 cm. long) extends about one-third the length of the radius, i.e., nearly as far distad as M. pronator brevis. The muscle arises by a tendon from the lateral epicondyle of the humerus; some fleshy fibers also arise from the tendon of origin of M. extensor digitorum communis.

M. FLEXOR METACARPI RADIALIS (extensor carpi ulnaris)

This muscle exhibits similar relationships in the two cranes. In the Sandhill Crane it is a very small, spindle-shaped muscle 13 cm. long, but it is only about 0.5 cm. in maximum width. It arises from the distal end of the humerus in common with, and superficial to, the anconeus tendon. Fleshy fibers arise from this tendon 5 to 6 cm. from its humeral origin. As in the Whooping Crane, there is an aponeurotic attachment to the proximal end of the ulna. The muscle inserts near the base of the intermetacarpal space; the tendon of insertion is ossified.

M. PRONATOR BREVIS AND M. PRONATOR LONGUS (pronator sublimus and pronator profundus)

These two muscles have the same relationships as in *G. americana*. M. pronator longus (belly 10 cm. long) extends distad further than M. pronator brevis (belly 8 cm. long), but extends less than half way down the forearm. M. pronator brevis extends slightly more than one-third the length of the radius; it inserts primarily by an aponeurosis, beginning 4 cm. from the proximal end of the radius and extending to within 13.5 cm. of the distal end of that bone. The two muscles insert on about the same areas in *G. c. tabida* and *G. americana*: M. pronator longus over an area about 7 cm. long; M. pronator brevis over an area 4 to 5 cm. long.

M. EXTENSOR LONGUS DIGITI II (extensor pollicis longus)

This muscle exhibits the same relative development in the two birds. In the Sandhill Crane, it arises from the radius (for a distance of 6 cm.) and from the ulna (for a distance of only 2 cm.). The ulnar origin begins immediately distal to the biceps insertion. The small belly (about 13 cm. in overall length) is located in about the proximal half of the forearm; it is rounded distally, but is a flat muscle-sheet proximally and posteriorly. The tendon is ossified, except near the insertion, where it fuses with the tendon of M. extensor metacarpi radialis; the common tendon inserts on the extensor process of metacarpal II (I).

M. ANCONEUS (anconaeus)

This muscle is similar in the two species. In the Sandhill Crane it arises by a very large tendon, much larger than the tendons of Mm. extensor digitorum communis or supinator. The belly (about 13 cm. long) extends distad slightly more than half the length of the ulna, and thus inserts on somewhat more than the proximal half of that bone.

M. EXTENSOR LONGUS DIGITI III (extensor indicis longus)

Relative to the size of *G. americana* and *G. c. tabida* and to the development of this muscle in genera of other families, M. extensor longus digiti III might almost be considered rudimentary in the cranes. In the Sandhill Crane this muscle has a very small, spindle-shaped belly 12 cm. long but only about 3 mm. in maximum width. It arises

from the posterior surface of about the distal half of the radius in the Sandhill Crane and from the "middle third" of this bone in the Whooping Crane (Fisher and Goodman, 1955:64). It inserts on the distal phalanx of digit III (II).

M. FLEXOR DIGITORUM PROFUNDUS

This muscle has similar relationships in the two species. The relatively poorly developed belly (10 cm. long) in the Sandhill Crane is limited to less than the proximal half of the ulna. It has a V-shaped origin at the inferior margin of the insertion of M. brachialis; the origin extends to the origin of M. flexor carpi ulnaris brevis. The tendon of insertion is ossified except where it passes around the distal end of the ulna and into the manus; it inserts on the anteroventral corner of the distal phalanx of digit III (II). Thus, this muscle inserts on that phalanx *proximal* to the insertion of M. flexor digitorum sublimus.

M. FLEXOR DIGITORUM SUBLIMUS

Fisher and Goodman do not discuss this muscle, though they describe it as the "anterior part" of M. flexor carpi ulnaris. Shufeldt (1890:141) and Fisher (1946:598) also interpreted this complex in a similar manner. This "anterior part" is the flexor digitorum sublimus muscle as I have seen it in other genera and as it is described by Gadow and Selenka (1891:278). Though it might be considered rudimentary in the cranes, it definitely is present. The situation is confused because most of the muscle-complex is tendon and aponeurosis.

The strong tendon of origin (Fig. 1) arises from the distal end of the humerus, posterior to the origin of M. pronator longus, as described for the Whooping Crane by Fisher and Goodman (1955:66). From the posterior edge of this tendon, a thin but extensive aponeurosis passes posteriad to attach to the ulna; distally, the tendon inserts, in part, on the anterobasal corner of the os ulnare (os cuneiform), but has several small slips, which pass into the manus to fuse with the deep fascia on the palmar surface. These relationships are found both in *G. americana* and *G. c. tabida*. The rudimentary, bipinnate, fleshy belly (about 10 cm. long) of the flexor digitorum sublimus muscle arises from the anterior surface of the aponeurosis and from the deep surface of the main humeral tendon. The fleshy fibers begin about 4 cm. distal to the humerus. The small, ossified tendon of insertion of the sublimus muscle is entirely separate from the main (humeral) tendon, which inserts on the anterior edge of the ulnare; the latter attachment represents an accessory insertion of this complex and is not found in all families of birds. The sublimus tendon becomes fibrous as it passes around the anterior surface of the ulnare (anterior to the tendon of M. flexor carpi ulnaris and posterior to the accessory tendon of the sublimus muscle) and into the manus, where again it becomes ossified. The tendon passes distad along the anterior surface of the carpometacarpus and inserts primarily on the anterior edge, about mid-length, of the distal phalanx of digit III (II), but there is a fascial continuation to the tip of that phalanx. The flexor digitorum sublimus tendon, therefore, has a more distal insertion than the flexor digitorum profundus tendon. Fisher and Goodman (1955:66–67) also described this insertion in their discussion of the "anterior part" of M. flexor carpi ulnaris; see also Fisher, 1946:606 and Fig. 13.

M. FLEXOR CARPI ULNARIS

If one excludes the anterior part (= M. flexor digitorum sublimus) as described by Fisher and Goodman (1955:65–67), this muscle exhibits about the same development in *G. americana* and *G. c. tabida*. In *Grus* and apparently in all other birds, M. flexor carpi ulnaris arises by a very strong tendon from the medial (internal) humeral condyle and immediately passes through a strong humero-ulnar pulley. I have never seen any

departure from this relationship. In the Sandhill Crane the belly is relatively poorly developed. The bulk of the belly (total length about 15 cm.) is located in the proximal third of the forearm, though a small bundle of fleshy fibers accompanies the tendon almost to the distal end of the ulna. The strong, ossified tendon of insertion forms on the anterior surface of the belly at about the junction of the first and second fourths of the forearm; it inserts on the posterobasal portion of the ulnare. As in the Whooping Crane, the "superficial fasciculus of the posterior part" of M. flexor carpi ulnaris "attaches to the fascia over the bases of the feathers arising from the proximal two-thirds of the ulnar length" (Fisher and Goodman, 1955:67); in the Sandhill Crane, a small tendon forms from this posterior belly and also inserts on the base of the ulnare.

M. FLEXOR CARPI ULNARIS BREVIS (ulnimetacarpalis ventralis)

This is a well developed muscle, similar in the two cranes. In the Sandhill Crane the belly (about 12.5 cm. long) arises from slightly more than the distal half of the ulna. It has the typical relationships to the origin of M. flexor digitorum profundus.

M. ABDUCTOR ALAE DIGITI II (abductor pollicis)

This muscle, apparently, is similar in the two cranes. In each it has both a palmar and an anconal head. In the Sandhill Crane, as in all other genera I have dissected, the palmar belly arises from the tendon of insertion of M. extensor metacarpi radialis. Fisher and Goodman (1955:68) state that in *G. americana* this head arises from "the base of the extensor process" and by "tendinous fibers from the inserting tendon of M. tens. pat. longus." This is not true for the Sandhill Crane: the palmar head arises only from the tendon of M. extensor metacarpi radialis. There is a strong insertion of M. tensor patagii longus on the extensor process, but the tendon then fans out to become continuous with the deep fascia of the manus on both its dorsal and palmar surfaces. On both surfaces, this fascia passes superficially over the two heads of the abductor alae digiti II, but none of the fibers of this muscle arise from the tendon of tensor patagii longus.

The anconal head of the abductor alae digiti II arises from the extensor process; it inserts on the anterior corner of the base of digit II (pollex). The palmar head inserts by fleshy and tendinous fibers on the anterior edge of digit II in its basal half.

M. ADDUCTOR ALAE DIGITI II (adductor pollicis)

This muscle is well developed in the cranes. In the Sandhill Crane it arises by a flat aponeurosis about 1 cm. wide from metacarpal III (II). The bulky belly passes anteriad to insert on most of the posterior surface of digit II (pollex).

M. FLEXOR DIGITI IV (flexor digiti III)

This is a weakly developed muscle in the cranes. In the Sandhill Crane the belly is 3 cm. long and less than 0.5 cm. wide.

M. FLEXOR BREVIS DIGITI IV (flexor brevis digiti III)

This structure in the cranes is composed mostly of connective tissue (Fisher and Goodman, 1955:68). I agree with Hudson that it would be better to consider this not as a separate muscle, but simply as a distal part of the preceding muscle.

M. ABDUCTOR MINOR DIGITI III (abductor digiti II)

I have never seen such a muscle. In all birds that I have dissected, this structure is a ligament connecting the carpometacarpus with digit III.

M. FLEXOR METACARPI BREVIS

This muscle is absent in *G. americana* and in *G. c. tabida*. Hudson and Lanzillotti (1955:35 and 43) suggest that this name "be dropped from the literature" inasmuch as this muscle represents a distal head of M. extensor indicis longus (extensor longus

digiti III). Data which I have obtained suggest that this head may be of taxonomic use in some families. I think, therefore, that it would be convenient to retain the name flexor metacarpi brevis for indicating the presence or absence of this small muscle.

M. INTEROSSEUS DORSALIS

This muscle is similar in the two cranes. In the Sandhill Crane, it inserts primarily on the base of the distal phalanx of digit III (II); a small tendon continues to the tip of the digit.

M. INTEROSSEUS VENTRALIS (interosseus volaris)

In *G. americana* this muscle inserts on "the posterior aspect of phalanx 2, about three-fourths of the way out its length" (Fisher and Goodman, 1955:69). The insertion is similar in *G. c. tebida*, but the tendon is also anchored to the base of the distal phalanx of digit III (II).

M. EXTENSOR BREVIS DIGITI II (extensor pollicis brevis)

This very small muscle (belly about 1.5 cm. long) is developed as illustrated for the Whooping Crane by Fisher and Goodman (1955: Fig. 18).

M. ABDUCTOR MAJOR DIGITI III (abductor indicis)

This muscle is similar in the two species. In the Sandhill Crane, the muscle is mostly tendinous, though a few fleshy fasciculi arise at the level of the pisiform process. The ossified tendon forms at about the junction of the proximal and middle thirds of the carpometacarpus; the insertion is typical. The very small, deep head, described for *G. americana* by Fisher and Goodman is present in *G. c. tabida*.

M. FLEXOR DIGITI II (flexor pollicis)

Similar in the two cranes, this small (1.5 cm. long), fleshy muscle arises from the base of the carpometacarpus and inserts on the posterobasal corner of digit II (pollex) in the Sandhill Crane.

M. FLEXOR METACARPI POSTERIOR (ulnimetacarpalis dorsalis)

This is a poorly developed muscle with a belly 3.5 cm. long. In general, it has the same relationships as described by Fisher and Goodman (1955:70), except that in *G. c. tabida* the two smaller heads are mostly tendinous bands.

Myology of the Leg

M. EXTENSOR ILIO-TIBIALIS LATERALIS (iliotibialis)

This extensive muscle is similar in the two cranes. In the Sandhill Crane it arises by an aponeurosis from the entire anterior iliac crest and from all but the caudal 1 cm. of the posterior iliac crest. Some of the origin posteriorly is by fleshy fibers. It is throughout a thin sheet of muscle, but the posterior edge is the thickest. As Fisher and Goodman (1955:76) pointed out, "the fibers in the center of the muscle are less than half as long as those of the anterior and posterior edges." The distal half of the central part of the muscle is aponeurotic and is fused with the underlying muscles. The extensor ilio-tibialis lateralis muscle conceals from superficial view the anterior and superior half of M. extensor ilio-fibularis (= biceps femoris), but it does not conceal the bellies of Mm. flexor cruris lateralis and flexor cruris medialis.

M. EXTENSOR ILIO-TIBIALIS ANTERIOR (sartorius)

In the Sandhill Crane, this muscle arises primarily by an aponeurosis shared with pars posterior of M. latissimus dorsi from the neural spine of the last dorsal vertebra and from the anterior 5 cm. of the median dorsal ridge of the synsacrum. In the Whooping Crane, there is no origin from the last dorsal vertebra. In general, however, the muscle exhibits the same configuration in the two cranes. In the Little Brown

Crane, Hudson (1937:17) found the origin from the "anterior edge of the ilium only." The insertion in the Sandhill Crane is as described by Fisher and Goodman (1955:79).

M. PIRIFORMIS (gluteus medius et minimus)

As stated by Fisher and Goodman (1955:79), this muscle is similar in the two cranes, but it is "more strongly developed" in *G. c. canadensis*. In *G. c. tabida* it is a triangular-shaped muscle, 2 cm. wide at its base (origin) and about 4 cm. long. It inserts on the femur by a flat tendon anterodistal to the insertion of M. gluteus profundus (= iliotrochantericus posterior).

M. GLUTEUS PROFUNDUS (iliotrochantericus posterior)

Similar in the two cranes, none of the fibers of this muscle arise directly dorsal to the acetabulum, this area being pre-empted by the origin of M. gluteus medius et minimus (= piriformis).

M. ILIACUS (iliotrochantericus anterior)

This muscle is similar in the two cranes. Its relationships to M. iliotrochantericus medius are described below. (See Fisher and Goodman, 1955: Figs. 29 and 30.)

M. ILIOTROCHANTERICUS MEDIUS

Gadow and Selenka (1891:142) and Hudson (1937:60, 69) reported that they did not find this muscle in the genus *Grus*, but Fisher and Goodman (1955:123) found it in *G. americana* and *G. c. canadensis*. I found it bilaterally in two specimens and unilaterally in a third specimen of *G. canadensis tabida*. This muscle and M. iliotrochantericus anterior are separate at their origins only; the bellies fuse distally and insert by a common, wide (1.5 cm.) aponeurosis. In the right hip of one specimen, the iliotrochantericus anterior and iliotrochantericus medius muscles are completely fused, so that this complex is represented by a single muscle-mass, arising from the same area, however, occupied by both muscles in the other dissections. The fusion of these two muscles is an example of the general tendency toward fusion of muscles which arise from adjacent areas and whose fibers are parallel. The common tendon inserts on the femur just distal to the insertion of M. iliotrochantericus posterior. Though there are two distinct tendons of insertion for the three iliotrochanterici muscles, there is an almost continuous line of insertion for a distance of 3 cm., beginning on the trochanter.

MM. VASTUS LATERALIS AND VASTUS MEDIALIS (femoritibialis externus and medius)

There are no significant differences in this complex between the two cranes; see, however, the discussion of "M. femoritibialis externus" below.

M. EXTENSOR ILIO-FIBULARIS (biceps femoris)

This muscle is similar in the two cranes. In the Sandhill Crane the well developed belly arises mostly by fleshy fibers from all but the posterior 1 cm. of the posterior iliac crest. The strong tendon inserts on the fibula 4 cm. distal to the proximal articular surface of that bone.

M. FLEXOR CRURIS LATERALIS (semitendinosus and accessorius semitendinosi)

This complex exhibits a similar configuration in the two cranes. In the Sandhill Crane the semitendinosus muscle arises from approximately the posterior 1 cm. of the posterior iliac crest. The raphe which separates the semitendinosus from the accessory semitendinosus continues downward between pars media and pars interna of M. gastrocnemius to become continuous with the tendon of that muscle; the raphe is ossified about the middle of the belly of M. gastrocnemius. In its course between the two heads of that muscle, the raphe is accompanied by a small fleshy belly, the "distal accessory" head of Fisher and Goodman.

As in the Whooping Crane, there are two distinct parts to the accessory semitendinosus

muscle (Fisher and Goodman, 1955:83). The more proximal part inserts by fleshy fibers on the posterior surface of the medial condyle and the intercondylar region (popliteal region) of the femur, immediately proximal to the common origin of Mm. flexor hallucis longus, flexor perforatus digiti III, and flexor perforatus digiti IV, and the tendon of origin of M. gastrocnemius, pars media. The attachment to the femur is nearly transverse in direction, rather than vertical, as in many birds. The more distal part of the accessorius muscle (distal accessory head) passes lateral to the tendon of insertion of M. flexor cruris medialis (= semimembranosus) and does not insert on the belly of M. gastrocnemius, pars media, as it does in the Whooping Crane.

M. FLEXOR CRURIS MEDIALIS (semimembranosus)

This muscle is similar in the two cranes. The tendon of insertion is intimately fused with the raphe of the accessory semitendinosus and pars media of M. gastrocnemius, just before the latter fuses with the internal head of the gastrocnemius. The muscle inserts by a thin aponeurosis (2.5 cm. long and about 1.5 cm. wide) on the tibiotarsus, beginning about 3 cm. distal to the proximal end of that bone. In the Whooping Crane the tendon inserts "some five centimeters from the proximal end" of the bone.

M. CAUDOFEMORALIS (piriformis)

Fisher and Goodman (1955:85 and 123) emphasized the amount of variation they found in this complex. They found both pars caudofemoralis and pars iliofemoralis in two specimens of the Whooping Crane, but only pars iliofemoralis in a third specimen. In one dissection, they found three parts to the muscle.

I found both parts to this muscle in three specimens of the Sandhill Crane. Pars iliofemoralis is a very thin, triangular sheet of muscle, 2 cm. wide at its base, where it arises primarily by an aponeurosis from the ventral surface of about the middle third of the posterior iliac crest; the belly is approximately 6 cm. in length. It inserts by a fleshy band (about 5 mm. wide) on the lateral surface of the femur, beginning about 3.5 cm. distal to the trochanter and 1 cm. distal to the insertion of M. ischiofemoralis.

Pars caudofemoralis has a small spindle-shaped belly, 8 to 9 cm. long and only about 6 mm. in maximum width. It arises by a small tendon (3 cm. long, but only 0.5 mm. in diameter) from the fascia covering the depressor muscles of the tail; I found no direct bony attachment on the pygostyle. This tendon passes through a bony notch at the most caudal end of the projecting posterior iliac crest; the tendon is held in the notch by a ligament, which completes a fibro-osseous canal. The muscle inserts by a long, flat tendon (2 cm. long and 2 mm. wide) about 3 cm. distal to the trochanter and directly medial to the insertion of pars iliofemoralis.

M. FLEXOR ISCHIOFEMORALIS (ischiofemoralis)

This muscle is well developed in these cranes. In the Sandhill Crane it inserts on the femur about 1 cm. proximal to the insertion of M. caudofemoralis (see above). There is a striking difference in the relationships of the tendons of insertion of M. ischiofemoralis and the two parts of M. caudofemoralis in the Whooping Crane as described and illustrated by Fisher and Goodman (1955:86 and Figs. 30 and 31). They state that M. ischiofemoralis inserts "posterior to and between the insertions of the two parts of M. caudofem." In no genus have I seen the condition illustrated in Fisher and Goodman's Figure 31. In the Sandhill Crane, pars caudofemoralis inserts medial to pars iliofemoralis.

MM. ADDUCTOR SUPERFICIALIS ET PROFUNDUS (adductor longus et brevis)

These two muscles exhibit about the same relative development in the two cranes. M. adductor profundus is entirely fleshy at its origin in the Sandhill Crane and I did

not find a conspicuous "heavy layer of tendon" covering the medial surface of this muscle such as Fisher and Goodman (1955:88) described for the Whooping Crane. The glistening muscular fascia is well developed, however.

M. AMBIENS

Fisher and Goodman (1955:88–89) called attention to the differences in termination of the ambiens tendon in *G. americana* and *G. c. canadensis*. In the former, the ambiens tendon serves as the "principal, if not sole, origin for M. flex. perf. dig. II, although there is strong fascial interconnection between the origins of Mm. flex. perf. dig. II, III, and IV, and in one instance there is actually a branch of the main ambiens tendon that goes to the tibiotarsus." In the Little Brown Crane, "M. ambiens connected distally to the small lateral head of M. flex. perf. dig. III. It had little connection with M. flex. perf. dig. II and none with M. flex. perf. dig. IV."

In the Sandhill Crane, I found that the ambiens muscle arises primarily by a flat tendon from the pectineal process. The small, spindle-shaped belly is 6 to 8 cm. long and less than 1 cm. in maximum width. Distally, a very small tendon (1 mm. wide) forms and has the usual course through the patellar ligament. The tendon then passes distad medial to the biceps tendon and serves as the primary origin for the lateral head of M. flexor perforatus digiti III; the ambiens tendon does not give rise to any other muscle.

M. FEMORITIBIALIS INTERNUS

There are minor differences between the Whooping and the Sandhill cranes in development of this muscle mass and I found variation in the pattern in the three specimens I dissected. In one right leg, the muscle was indistinctly divided into two heads. In another right leg, one long and two short heads were present; each gave rise to a tendon and the three tendons fused for a common insertion. In the other dissections, there were two distinct heads. The posterior or long head arises from the posteromedial surface of the femur, beginning a short distance proximal to the area of insertion of M. iliacus; the origin is fleshy as far as the medial condyle. The short or distal head arises from a small area (about 2 cm. long) on the anteromedial surface of the femur, just above the medial condyle. The small tendon from the latter head fuses with the patellar ligament and with the tendon of the long head; the combined tendon inserts on the medial corner of the tibiotarsus at the base of the inner cnemial crest.

"M. FEMORITIBIALIS EXTERNUS"

As Fisher and Goodman (1955:89–90) imply, there is some confusion concerning the muscle they consider under this name and their M. vastus lateralis. Fisher (1946: Table 42) stated that his M. vastus lateralis was a synonym for M. femoritibialis externus of Gadow and Selenka (1891:154) and Hudson (1937:20). This muscle was discussed earlier by Fisher and Goodman on page 81.

The muscle which Fisher and Goodman call "M femoritibialis externus," I believe is simply a distal head of their vastus lateralis (= femoritibialis externus). I considered this head a part of M. femoritibialis externus in the cuckoos (Berger, 1953:68 and Fig. 6); it was illustrated, but not given a special name. Mitchell (1901:647 and Text-fig. 79) also called attention to this distal part in gruiform birds. In the Sandhill Crane, the distal head of M. femoritibialis externus arises from the posterior and lateral surfaces of the distal half of the femur, posterior to the more distal origin of Fisher and Goodman's vastus lateralis. The tendon of the distal head fuses, in part, with the patellar ligament, but the strongest portion of the tendon passes distad to insert on the outer cnemial crest of the tibiotarsus.

Fisher and Goodman (*loc. cit.*) also state that Gadow and Selenka's (1891:155) "M. femoritib. medius is apparently lacking . . . or is fused to M. femoritib. ext." in the Whooping Crane. However, Fisher (1946: Table 42) placed his M. vastus medialis in synonymy with Gadow's femoritibialis medius, which Fisher and Goodman described on pages 81 and 82. The discussion by Gadow and Selenka (1891:155) of the origin of the femoritibialis complex is not entirely clear, but points out that the femoritibialis medius passes directly to the patella, and, in many birds, the fleshy fibers do insert on the proximal surface of that sesamoid (see Hudson, 1937:20; Berger, 1953:68).

M. OBTURATOR EXTERNUS

Fisher and Goodman (1955:90) said that "Hudson (1937:28) stated that M. obt. ext. had two distinct parts in *G. canadensis*; our dissection of this species showed the separation to be superficial only."

In the Sandhill Crane, also, this muscle may be a single mass or may be partially separated into two heads. It is a broad band of fleshy fibers with a nearly continuous origin from the anterodorsal and anteroventral margins of the obturator foramen. The belly conceals much of the tendon of M. obturator internus. The externus has a broad fleshy insertion (1 cm. wide) on both sides (proximal and distal) of the tendon of M. obturator internus.

M. OBTURATOR INTERNUS

This muscle is triangular in shape. It does not arise inside the pelvic cavity, as it does in *Porzana* and *Coua*. The fibers converge to a tendon, which emerges through the obturator foramen and inserts on the posterolateral surface of the femur, less than 1 cm. from the trochanter.

M. PSOAS (iliacus)

This is a flat, fleshy band about 4 cm. long and 0.5 cm. wide. It arises from the ventral edge of the ilium about 1 cm. anterior to the acetabulum. It inserts by fleshy fibers on the femur for a distance of 1 cm., beginning 1 cm. distal to the neck of the femur, just proximal and somewhat posterior to the origin of M. femoritibialis internus. Fisher and Goodman (1955:90) said that "the condition described by Fisher (1946:670) for the cathartid vultures is found" in the Whooping Crane.

M. GASTROCNEMIUS

The three heads of this complex are, in general, similar in the two cranes. The following specific points may be mentioned for the Sandhill Crane.

Pars externa arises from the lateral condyle of the femur, as described by Fisher and Goodman (1955:91). The tendon of origin is, in part, fused to the biceps loop.

Pars interna has an extensive origin from the medial surface of the inner cnemial crest and from the patellar ligament. In fact, the fibers of M. sartorius and part of those of pars interna insert and arise, respectively, from a tendinous raphe separating the two muscles.

Pars media arises by a flat tendon from the intercondylar (popliteal) area of the femur, just proximal to the common tendon of origin for the long flexors. Fleshy fibers begin about 3 cm. from the femoral origin of the tendon. In the left leg of one specimen, I found an *accessory medial head*. This head (5 cm. long, but less than 1 cm. wide at the origin) arises from the posterior surface of the medial condyle of the tibiotarsus. The belly passes lateral to the inserting tendon of M. semimembranosus and anterior to the tendon of the distal accessory belly of M. accessorius semitendinosi. The belly tapers to a minute tendon, which fuses with the fascia covering the deep surface of pars externa (gastrocnemius) in the area where this head fuses with pars media.

M. PERONEUS LONGUS

Similar in the two cranes, this is a well developed muscle, which conceals all of M. tibialis anterior. The strong tendon of insertion forms as ossified radiating bands on the superficial surface of the belly. The tendon inserts on the tendon of M. flexor perforatus digiti III, 4 cm. distal to the proximal end of the tarsometatarsus. (See also Mitchell, 1913:1053.)

M. TIBIALIS ANTERIOR

Similar in general configuration in the two cranes, the femoral head (whose tendon is ossified) is almost equal in bulk to the tibial head in the Sandhill Crane. The common, ossified tendon bifurcates at the insertion on the tarsometatarsus, about 2 cm. from the proximal end of that bone, but the two tendons insert adjacent to each other.

M. FLEXOR PERFORANS ET PERFORATUS DIGITI II

In general, this muscle is similar in the two cranes. In one specimen of *G. c. tabida*, the belly was not bipinnate. Fisher and Goodman (1955:94) found this muscle "not clearly bipinnate" on one side of a specimen of *G. c. canadensis*. The total length of the belly is about 8 cm.; fleshy fibers extend further distad in the anterior half of the belly. The tendon of insertion is calcified in the region of the crus and tarsometatarsus, but not over the intratarsal joint. Fisher and Goodman found fusion between the tendons of Mm. flexor perforans et perforatus digiti II and flexor perforatus digiti II in *G. c. canadensis* (see also Mitchell, 1901:653), but not in *G. americana*. I did not find such fusion in *G. c. tabida*. The tendon of M. flexor perforans et perforatus digiti II perforates the tendon of M. flexor perforatus digiti II and is perforated by the tendon to digit II of M. flexor digitorum longus, as described by Fisher and Goodman (1955:94).

M. FLEXOR PERFORANS ET PERFORATUS DIGITI III

This muscle has a small (10 cm. long) bipinnate belly. The tendon perforates and is perforated. Hudson (1937:42) and Fisher and Goodman (1955:97) found a vinculum connecting the tendon of this muscle with the tendon of M. flexor perforatus digiti III in *G. c. canadensis*, but Fisher and Goodman did not find such a vinculum in *G. americana*. This vinculum is present in *G. c. tabida*. The vinculum is short (about 0.5 cm. long), but strong, and is located about 3 cm. from the distal end of the tarsometatarsus.

M. FLEXOR PERFORATUS DIGITI IV

The origin and insertion of this muscle in the Sandhill Crane are similar to those described for the Whooping Crane by Fisher and Goodman (1955:96). My specimens also exhibited the peculiar lateral head, which passes distad lateral to the biceps tendon before fusing with the medial head. The bulk of the muscle lies medial to the biceps tendon. Mm. flexor perforatus digiti IV, flexor perforatus digiti III, and flexor hallucis longus have a common origin, fleshy and tendinous, from the intercondylar area of the femur. This common origin is located just distal to the insertion of the accessory semitendinosus muscle and lateral to the origin of pars media of the gastrocnemius.

M. FLEXOR PERFORATUS DIGITI III

In the Sandhill Crane, the posterior head arises as described for the Whooping Crane by Fisher and Goodman. The much smaller lateral head is, in part, a direct continuation of the ambiens tendon, but a long (7 cm.), flat tendinous band, attached proximally to the head of the fibula, fuses with the ambiens tendon, just proximal to the origin of the fleshy fibers of M. flexor perforatus digiti III. This tendinous band is intimately associated with the lateral head of M. flexor perforatus digiti II. The fleshy fibers of the lateral head of M. flexor perforatus digiti III begin about 8 cm. distal to the proximal end of the fibula. There is a well developed vinculum between the tendon

of this muscle and the tendon of M. flexor perforans et perforatus digiti III. The tendon of insertion is perforated by both of the deep flexor tendons.

M. FLEXOR PERFORATUS DIGITI II

This muscle is as decribed for the Whooping Crane by Fisher and Goodman (1955: 97–98). Both heads are present in the Sandhill Crane. The lateral head (about 4.5 cm. long) arises by fleshy fibers from the patellar ligament and associated fascia and from the tendinous band mentioned above. This head is not connected with the ambiens tendon. The medial, or deep, head, about the same length, arises by a flat tendinous band from the femoral tendon of origin of M. flexor perforatus digiti III (part of the tendon is calcified). The inserting tendon of flexor perforatus digiti II is perforated by the tendon of flexor perforans et perforatus digiti II, although the bulk of the tendon inserts on the lateral side of the proximal phalanx, as described by Fisher and Goodman (1955:98).

M. FLEXOR HALLUCIS LONGUS

The origin of this muscle in the Sandhill Crane is the same as Fisher and Goodman (1955:98) described for the Whooping Crane. The relatively small belly (15 cm. long) extends about half way down the tibiotarsus, but it is one of the best developed muscles on the posterolateral aspect of the crus. The tendon of insertion in the Sandhill Crane differs in that it does not pass through a bony canal in the hypotarsus (see also Hudson, 1937:69); it does pass through such a canal in the Whooping Crane (Fisher and Goodman, 1955:99). Fisher and Goodman have pointed out that "in most birds there is some sort of a connection between" the tendons of Mm. flexor hallucis longus and flexor digitorum longus, "but Hudson (1937:48) did not find fusion of them in *Grus* [*c.*] *canadensis* (nor did we); he noted only a vinculum between them, as was the case in one of our Whooping Cranes." In one of my specimens of the Sandhill Crane, however, most of the tendon of flexor hallucis longus fused with the tendon of flexor digitorum longus in the distal one-fourth of the tarsometatarsus. Only a very small branch of the hallucis tendon continued directly to the hallux; this tendon was not ensheathed by the tendon of M. flexor hallucis brevis. Fisher and Goodman also were unable to demonstrate such a perforation of the brevis tendon in *G. americana.* In a second specimen of *G. c. tabida* the tendon of flexor hallucis longus did not fuse with the tendon of flexor digitorum longus, but they were connected by a strong vinculum (representing over half of the hallucis tendon), 4 cm. proximal to the distal end of the tarsometatarsus; the remainder of the hallucis tendon inserted on the hallux. In a third specimen, the two tendons were connected by a weak vinculum (2.5 cm. long), but the hallucis tendon retained its integrity throughout. Mitchell (1901:654) illustrated the considerable intergeneric variation in the pattern of these two deep plantar tendons in several gruiform birds.

M. FLEXOR DIGITORUM LONGUS

In the Sandhill Crane, the belly (13.5 cm. long) of this muscle is slightly shorter than the belly of M. flexor hallucis longus (15 cm.). The lateral head is the larger; the medial head is short and small. The tendon of this muscle alone passes through the single bony canal in the hypotarsus. The insertion is typical.

M. PERONEUS BREVIS

This muscle is poorly developed in the cranes (see Mitchell, 1913:1053). In the Sandhill Crane, the belly is 13.5 cm. long, but it is less than 0.5 cm. wide. The origin begins at the level of insertion of the biceps tendon, as in the Whooping Crane. The insertion is typical (see Fisher and Goodman, 1955:99–100).

M. EXTENSOR DIGITORUM LONGUS

The belly of this muscle is about 14 cm. long, but only 1 cm. in maximum width at the head of the tibiotarsus. The tendon of insertion passes through a bony canal at the distal end of the tibiotarsus, but it is held in place by a ligament on the proximal end of the tarsometatarsus. The general development is the same as described for the Whooping Crane by Fisher and Goodman (1955:100).

M. POPLITEUS

Typical in origin and insertion in the Sandhill Crane, this small muscle is about 2 cm. long and 1.3 cm. wide. It arises on the fibula, inserts on the tibiotarsus.

M. PLANTARIS

This is a very small muscle in the Sandhill Crane. Its belly is about 7 cm. long, but only about 0.7 cm. in maximum width at the proximal end of the tibiotarsus. The minute tendon inserts on the medial corner of the tibial cartilage.

The short toe muscles are very poorly developed in the Cranes (Fisher and Goodman, 1955:102), although I found remnants of the following eight muscles in both legs.

M. EXTENSOR HALLUCIS LONGUS

This is relatively a very small muscle, 5 to 6 cm. long and with a maximum width of but 2 to 3 mm. It seems to arise exclusively from the fascia covering the anteromedial surface of the intratarsal joint. The tendon inserts on the medial side, and not on the dorsal surface, of the distal phalanx of the hallux.

M. EXTENSOR PROPRIUS DIGITI III

This muscle is rudimentary. I found a few fleshy fibers on the anterior surface of the distal half of the tarsometatarsus, but much of the muscle seems to be represented by semitendinous fibers.

M. EXTENSOR BREVIS DIGITI IV

This muscle also is rudimentary. Tendinous and fleshy fibers arise from about the distal third of the tarsometatarsus. The tendon is about 1 mm. wide; it passes through a bony canal between the trochleae for digits III and IV to insert on the medial surface of the base of the proximal phalanx, digit IV.

M. ABDUCTOR DIGITI II

The 3 cm.-long belly is composed of fleshy and tendinous fibers. It arises from the medial surface of the distal end of the tarsometatarsus. The tendon inserts on the medial side of the base of the proximal phalanx of digit II.

M. FLEXOR HALLUCIS BREVIS

This is a minute muscle, 3 to 4 cm. long and with a maximum width of about 3 mm. It arises primarily from the medial surface of the hypotarsus. It has a thin, hair-like tendon about 0.3 mm. wide. It inserts on the base of the hallux and is not perforated by the tendon of M. flexor hallucis longus.

M. ADDUCTOR DIGITI II

This muscle is typical in origin and relationships. The belly is 4 cm. long and 4 mm. in maximum width. It arises at the proximal end of the tarsometatarsus, immediately inferior to the hypotarsal area. The hair-like tendon is about 0.3 mm. wide. It inserts on the dorsomedial surface of the base of the proximal phalanx, digit II.

M. LUMBRICALIS

This muscle shows the poorest development of any of the short toe muscles, and I did not find it in all dissections. When present, it consists of scattered fleshy and

tendinous fibers, located at the distal end of the tarsometatarsus. These insert primarily on the cartilaginous pads for digits III and IV.

M. ABDUCTOR DIGITI IV

This is another minute muscle, having a length of about 4.5 cm. and a maximum width of 3 mm. The tendon is less than 0.5 mm. wide, but it expands distally and inserts on the lateral side of the base of the proximal phalanx of digit IV.

M. ADDUCTOR DIGITI IV

This muscle is not present in the Sandhill Crane, nor in the Whooping Crane (Fisher and Goodman, 1955:102).

SUMMARY

Only two of the 47 major wing muscles are absent in *Grus americana* and in *G. canadensis tabida*: Mm. flexor metacarpi brevis (see page 292) and entepicondylo-ulnaris. Pars propatagialis M. cucullaris (= "dermo-tensor patagii" of Shufeldt, 1890, but not of Fisher, 1946: 574) also is absent. The os humeroscapulare (see page 287) is absent in both cranes. The following similarities of wing muscles in the two cranes deserve special mention: The biceps slip arises from the coracoidal tendon of M. biceps brachii and has a typical insertion on the tendon of insertion of M. tensor patagii longus. Mm. tensores patagii longus et brevis are represented by a single fused belly. M. scapulotriceps has a strong aponeurotic anchor extending from the anterior edge of the belly to the humerus. M. flexor digitorum profundus has a more proximal insertion on digit III (of Fisher) or digit II (of Hudson) than M. flexor digitorum sublimus. The latter muscle, though its belly is very small, is present and similar in each. M. proscapulohumeralis is present in both cranes. M. subcoracoideus has a single head. The tendon of insertion of M. serratus anterior passes between the two heads (pars externa and pars interna) of origin of M. subscapularis. M. deltoideus major has the usual origin from the dorsolateral surface of the scapula and also has an accessory tendinous origin from the scapula caudal to the glenoid fossa. M. expansor secundariorum is well developed in *G. c. tabida* and undoubtedly in *G. americana*. The rudimentary M. anconaeus coracoideus is present in *G. c. tabida* and probably in *G. americana*. M. adductor alae digiti II (adductor pollicis) is an exceptionally well developed muscle, whereas Mm. flexor digiti IV (III), abductor major digiti III (abductor indicis), and flexor metacarpi posterior are poorly developed. M. latissimus dorsi metapatagialis is inconstant in both species.

The following differences between *G. americana* and *G. c. tabida* were noted in the wing muscles: M. pectoralis is divided into a superficial and a deep layer in *G. americana*, but not in *G. c. tabida*. The origins of Mm. latissimus dorsi, rhomboideus superficialis, and rhomboideus profundus are less extensive in *G. c. tabida* than in *G. americana*. There is a dermal component to M. deltoideus major in *G. americana*, but I did not find one in *G. c. tabida*. M.

deltoideus minor apparently has a single head in *G. americana;* it has two heads in *G. c. tabida.* M. serratus posterior is divided into a superficial and a deep layer in *G. americana,* but not in *G. c. tabida.* There are minor differences in the origins of all three serrati muscles. M. abductor alae digiti II (abductor pollicis) has two heads in both cranes; the anconal head arises from the extensor process of the carpometacarpus, the palmar head from the tendon of insertion of M. extensor metacarpi radialis. Fisher and Goodman (1955:68) state that in *G. americana* the palmar head arises, in part, by "tendinous fibers from the inserting tendon of M. tens. pat. longus"; it does not do so in *G. c. tabida.*

I doubt the existence of any separate muscle which might be called "M. proscapulohumeralis brevis." I agree with Hudson and Lanzillotti (1955:43) that M. flexor brevis digiti IV (III) probably is best considered simply a distal part of M. flexor digiti IV (III); that M. abductor indicis brevis is a deep fasciculus of M. abductor major digiti III (abductor indicis); and that M. abductor minor digiti III (abductor digiti II) is a ligament—I know of no bird in which there is a muscle in this position.

The leg muscle formula in the Sandhill Crane is ABC(±)DXYAmV. Mm. iliotrochantericus medius (C) and iliotrochantericus anterior are fused in some specimens. Hudson (1937:69) gave the formula for the Little Brown Crane (*G. c. canadensis*) as ABDXYAmV; I assume that the two iliotrochanterici muscles were fused in his specimen. In two specimens of the Whooping Crane, Fisher and Goodman found the formula to be ABCDXYAm; though they added V to the formula on page 124, they stated (page 97): "we did not find any vinculum between the tendons of M. flex. perf. dig. III and M. flex. perf. et perf. dig. III." In a third Whooping Crane, the formula was BCDXYAm.

The following features common to the Whooping and the Sandhill cranes deserve mention: The accessory semitendinosus muscle has two well developed heads. M. iliotibialis has a large aponeurotic portion in the center of its distal half. Mm. vastus lateralis (= femoritibialis externus) and vastus medialis (= femoritibialis medius) are similar in both cranes; M. vastus lateralis has two distinct heads of origin, one proximal and one distal.

In the Sandhill Crane the tendon of M. ambiens gives rise only to the lateral head of M. flexor perforatus digiti III; in the Whooping Crane the ambiens tendon serves as the "principal, if not sole, origin for M. flex. perf. dig. II." In the Sandhill Crane, M. flexor ischiofemoralis inserts on the femur proximal to the areas of insertion of both parts of M. caudofemoralis. In the Whooping Crane M. flexor ischiofemoralis inserts "posterior to and between the insertions of the two parts of M. caudofem." (Fisher and Goodman, 1955:86); this is a most unusual relationship for these tendons. Fisher and Goodman

(1955:94) found fusion of the tendons of Mm. flexor perforans et perforatus digiti II and flexor perforatus digiti II in *G. c. canadensis*, but not in *G. americana*; I did not find fusion of these two tendons in three specimens of *G. canadensis tabida*. In the Sandhill Crane, only the tendon of M. flexor digitorum longus passes through a bony canal in the hypotarsus; in the Whooping Crane the tendons of flexor digitorum longus and flexor hallucis longus pass through bony canals in the hypotarsus (Fisher and Goodman, 1955:99). I found considerable variation in the amount of fusion between the tendons of Mm. flexor digitorum longus and flexor hallucis longus (see page 299). Unilaterally in one Sandhill Crane, I found an accessory medial head, arising from the proximal end of the tibiotarsus, of pars media, M. gastrocnemius.

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DEPARTMENT OF ANATOMY, UNIVERSITY OF MICHIGAN MEDICAL SCHOOL, ANN ARBOR, MICHIGAN, MARCH 5, 1956

NEW LIFE MEMBER

Karl E. Bartel was born in Blue Island, Illinois, October 12, 1913, and now is employed by General Biological Supply House, Chicago. He has been interested in natural history since 1928. His bird watching developed into bird banding, and since 1933 he has banded over 30,000 individuals of 159 species. His interest is shifting now to wild flower photography, and to the building up of a series of wild flower slide lectures for rental purposes.

Mr. Bartel is a member of the American Ornithologists' Union, Illinois Audubon Society, Wisconsin Society of Ornithology, Nature Conservancy, Friends of our Native Landscape, Eastern, Western, and Inland Bird Banding associations, Wm. I. Lyon Bird Banding Council and the Chicago Ornithological Society. He is now President of the latter organization. In the picture he is holding a Red-bellied Woodpecker that he had just banded.

FOODS OF THE WILD TURKEY IN THE WHITE RIVER BOTTOMLANDS OF SOUTHEASTERN ARKANSAS

BY BROOKE MEANLEY

THE bottomland hardwoods of the lower Arkansas, White and Mississippi rivers, form one of the two best areas for the Wild Turkey (*Meleagris gallopavo silvestris*) in the state of Arkansas. The wilderness aspects of the area, inaccessibility of many sections, year around abundance of food, and an extensive refuge area along the lower White River provide conditions for maintaining a fairly stable turkey population. The Wild Turkeys found in this locality are apparently of a purer strain than those occurring in the south-central pine-hardwoods section of the state, a more accessible area in which there have been some introductions from game farms.

During the period 1950–1955, considerable information concerning the food of the turkeys in the White River bottomlands of Arkansas, Desha and Phillips counties in southeastern Arkansas was obtained and is here reported.

HABITAT TYPES

The lower White River area is characterized by a typical southern bottomland hardwoods forest, which is subject to flooding almost every winter and spring. In this bottomland forest elevation and soils are the principal physiographic features that determine characteristic plant communities or forest types.

In low, poorly-drained flat areas the overcup oak (*Quercus lyrata*)–bitter pecan (*Carya aquatica*) type (Putnam, J. A., 1951. *Occ. Paper 116, Southern Forest Exper. Sta., U.S. Forest Service*) is predominant and relatively unimportant to the turkey.

The sweet gum (*Liquidambar styraciflua*)–water oaks (*Quercus* spp.) type (*ibid*) is found throughout much of the better drained part of the first bottoms, and, when not inundated, is widely used by the turkeys when foraging. Characteristic species of this type (Fig. 1) are sweet gum, water oak (*Quercus nigra*), Nuttall oak (*Quercus Nuttallii*), willow oak (*Quercus phellos*), American elm (*Ulmus americana*), sugarberry (*Celtis laevigata*), and green ash (*Fraxinus pennsylvanica*, var. *lanceolata*). Secondary species are red maple (*Acer rubrum*), cedar elm (*Ulmus crassifolia*), and southern red oak (*Quercus falcata*). Plants commonly found in the shrub strata of this forest are swamp privet (*Forestiera acuminata*), deciduous holly (*Ilex decidua*), haw (*Crataegus sp.*), and saplings of the several trees predominant in this type. Common lianas include greenbriar (*Smilax* spp.), grape (*Vitis* spp.), supplejack (*Berchemia scandens*), Virginia creeper (*Parthenocissus quinquefolia*), peppervine (*Cissus* sp.), and poison ivy (*Toxicodendron radicans*).

FIG. 1. Open, park-like woods of Sweet Gum—Water Oaks type in first bottoms of lower White River. Wild Turkeys sought food in such sites in winter and early spring. Photograph by Peter J. Van Huizen.

Sweet gum, sweet pecan (*Carya illinoensis*) or southern red oak are often predominant on well-drained first-bottom ridges. Boykin's dioclea (*Dioclea multiflora*), a leguminous vine that produces a large seed, is strikingly abundant on these ridges. This first-bottom ridge type is the finest for turkey use; and it is not flooded except by unusually high overflows, perhaps once in seven or eight years.

Cypress (*Taxodium distichum*) and tupelo gum (*Nyssa aquatica*) are characteristic trees of bayous that flow into the White, but these do not rate as food producing trees for the turkey in this area.

Ox-bow lakes that are dry in summer are characteristic of the White River bottoms. These lake beds characteristically are surrounded by cypress trees but the beds are grown to grasses, sedges and other herbaceous vegetation. Grasses in the dry lake beds are utilized heavily by turkeys in droughty summers. Many of the ox-bow lakes are close to the river and the turkeys work back and forth to sand bars where they also feed on seeds of grasses, as well as grasshoppers (Orthoptera) and other insects.

The size of the present turkey population in the southeastern Arkansas bottomlands area is unknown. The last three years (1952–53–54) have been dry and have therefore favored the turkey population along the lower White,

FIG. 2. Sand bar along the lower White River used in late summer and fall by Wild Turkeys feeding on crabgrass seeds. Photograph by Peter J. Van Huizen.

which is normally subject to considerable overflow during the late winter and spring. During the fall many sand bars are exposed by low water stages (Fig. 2). In August, 1954, one observer in a boat counted 112 turkeys feeding on sand bars along a 12-mile stretch of the river, beginning at the southern boundary of the refuge and running north. Other observers counted 10 separate broods, totalling 110 turkeys along a six-mile stretch of the river, from July 17 to July 20, 1954.

FOODS TAKEN

A wide variety of plant and animal foods in the bottomlands are available to turkeys throughout the year. Fruits, seeds and herbaceous leaves form the great bulk of the turkey's food. Insects, while important on the basis of their frequency of occurrence in crops, gizzards and droppings, were consistently low in volume.

Crops of Wild Turkeys examined during the spring hunting season following a year when there is a good crop of sweet pecan mast usually contained from two or three to 15 whole nuts of this species (Fig. 3). During years of poor pecan mast, crops and gizzards were usually crammed full of sugar-

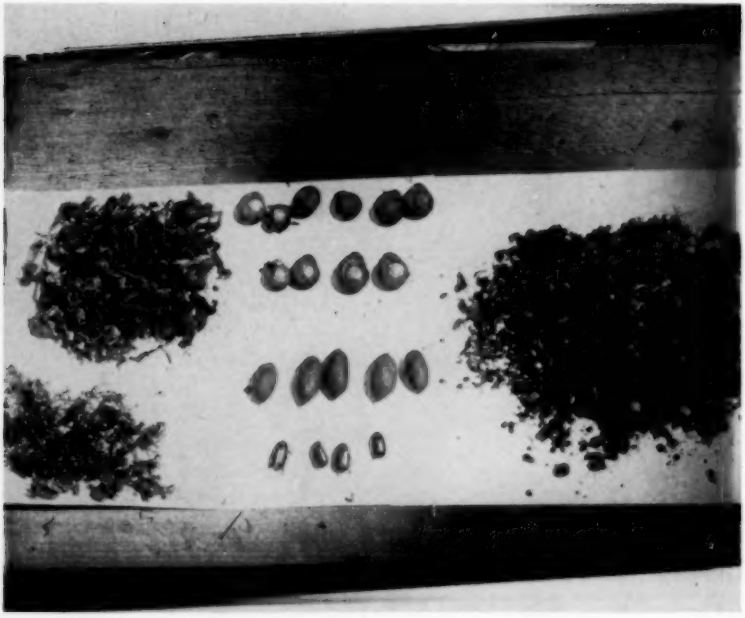

FIG. 3. Contents of the crop of a Wild Turkey collected in southeastern Arkansas in April, 1952. Food items include jack-in-the-pulpit leaves (upper left), poison ivy fruits and seeds (lower left), snails, sweet pecan nuts, scarabaeid beetles (center), grit and seeds of *Celtis* and *Berchemia* (right).

berry fruit, poison ivy fruit and seeds, oak mast, or perhaps some rather unusual plant food such as the catkins of cottonwood (*Populus deltoides*), flowers of the crossvine (*Bignonia capreolata*) and buttercup (*Ranunculus* sp.), or pods of vetch (*Vicia* sp.).

The seasonal abundance of food is further reflected in the turkey's diet as seen by an analysis of droppings gathered during June from bottomland woods in which blackberries or dewberries (*Rubus* sp.) were predominant; and in a series of droppings collected from sand bars and dry lake beds in the fall in which seeds of crabgrass (*Digitaria* sp.) and sprangletop grass (*Leptochloa panicoides*) respectively, were major foods on both a frequency of occurrence and volumetric basis. Snowbell (*Styrax americana*) had a high palatability rating in late summer and early fall with turkeys feeding along the river and in nearby dry lake beds. This woody shrub is usually found around the margins of old river bed lakes.

Orthoptera (mainly Acrididae and Gryllidae) and a number of slow-

TABLE 1

PRINCIPAL FOODS OF THE WILD TURKEY ON FIRST BOTTOM RIDGES ALONG THE WHITE RIVER IN ARKANSAS

(Per cent occurrence)

April — 22 crops or gizzards PLANT:		June — 60 droppings PLANT:		Winter — 112 droppings PLANT:	
Celtis laevigata fruit and seeds	90	*Rubus* sp. seeds*	87	*Quercus* sp. mast	94
Carya illinoensis nuts	55	*Carex* sp. achenes and perigynia	58	Gramineae blades	78
Nyssa sylvatica fruit and seeds	55	*Quercus* sp. mast	53	*Toxicodendron radicans* seeds	60
Quercus sp. mast	50	*Panicum* sp. seeds	40	*Crataegus* sp. seeds	47
Crataegus sp. seeds	45	*Forestiera acuminata* seeds	37	*Carex* sp. seeds	21
Vitis sp. fruit	40	*Rumex acetosella* leaves	35	*Vitis* sp. seeds	20
Berchemia scandens seeds	40	*Celtis laevigata* seeds	35	*Celtis laevigata* seeds	18
Toxicodendron radicans fruit and seeds	36	Undet. herbaceous dicot leaves	25	Undet. herbaceous dicot leaves	18
Polygonatum sp. seeds	36	*Ranunculus* sp. seeds	15	*Nyssa sylvatica* seeds	14
Undet. galls	32	*Styrax americana* seeds	15	*Carya illinoensis* nuts	12
Undet. seeds	27	*Alopecurus* sp. glumes	13		
Arisaema sp. leaves	23	Gramineae blades	10		
Undet. herbaceous dicot leaves	23				
Ranunculus sp. seeds	18				
Vicia sp. pods	18				
Ilex decidua seeds	13				
ANIMAL:		ANIMAL:		ANIMAL:	
Scarabaeidae	18	Scarabaeidae	47	*Nezara viridula*	44
Coleoptera	18	Formicidae	28	*Arilus cristatus*	28
Gastropoda	13	Coleoptera	12	Scarabaeidae	20
				Undet. insects	13

* With the exception of grass seeds, which were deliberately taken, other seeds were usually the remains of what were fleshy fruits at the time of ingestion.

moving insects belonging to the Scarabaeidae and Hemiptera were found to be important in the turkey's diet. Two large hemipterans, the southern green stinkbug (*Nezara viridula*) and wheel bug (*Arilus cristata*), so abundant in the winter droppings of turkeys, occur commonly throughout the winter beneath the leaf mantle of the riverbottom hardwoods.

During the late summer and early fall such crop pests as the fall armyworm (*Laphygma frugiperda*), spotted cucumber beetle (*Diabrotica undecimpunctata*), and rice stinkbug (*Solubea pugnax*) occur abundantly among the grasses and sedges of dry lake beds where they are taken readily by turkeys.

Data presented below were based on an analysis of 1026 droppings and 22 crops or gizzards, supplemented by field observations.

Crops and gizzards were obtained from local hunters. Most of the droppings were collected on the White River National Wildlife Refuge by Peter J. Van Huizen, Manager, and Lloyd C. MacAdams, Patrolman. The droppings

TABLE 2

PRINCIPAL FOODS OF THE WILD TURKEY ON SAND BARS ALONG THE WHITE RIVER IN ARKANSAS

(Per cent occurrence)

Summer — 200 droppings		Fall — 310 droppings	
PLANT:		PLANT:	
Digitaria sanguinalis seeds	75	*Digitaria sanguinalis* seeds	77
Celtis laevigata seeds	67	*Styrax americana* seeds	73
Styrax americana seeds	67	*Echinochloa crus-galli* seeds	66
Gramineae blades	14	*Vitis* sp. seeds	60
Panicum sp. seeds	10	*Panicum capillare* seeds	59
		Quercus sp. mast	24
		Leersia oryzoides glumes	24
		Digitaria (ischaemum) seeds	23
		Bumelia sp. seeds	20
		Panicum sp. seeds	18
		Solanum nigrum seeds	11
ANIMAL:		ANIMAL:	
Scarabaeidae	49	*Solubea pugnax*	52
Formicidae	45	Acrididae	40
Acrididae	27	Other Orthoptera	20
		Scarabaeidae	18
		Formicidae	10

TABLE 3

PRINCIPAL FOODS OF THE WILD TURKEY IN DRY LAKE BEDS ALONG THE WHITE RIVER IN ARKANSAS

(Per cent occurrence)

Summer — 100 droppings		Fall — 244 droppings	
PLANT:		PLANT:	
Styrax americana seeds	98	*Leptochloa panicoides* seeds	100
Celtis laevigata seeds	72	*Carya illinoensis* nuts	65
Leptochloa panicoides seeds	66	*Bumelia* sp. seeds	52
Vitis sp. seeds	66	*Vitis* sp. seeds	52
Bumelia sp. seeds	16	*Echinochloa crus-galli* seeds	41
Gramineae blades	16	*Styrax americana* seeds	40
Digitaria sp. seeds	10	*Leersia oryzoides* glumes	29
		Toxicodendron radicans seeds	16
ANIMAL:		ANIMAL:	
Scarabaeidae	78	*Diabrotica undecimpunctata*	31
Gryllidae	74	Scarabaeidae	27
Acrididae	70	Orthoptera	23
Laphygma frugiperda	14	Gryllidae	21
Gastropoda	14	Undet. insects	15
Formicidae	12	*Laphygma frugiperda*	13
Solubea pugnax	10	*Solubea pugnax*	13
Pentatomidae	10		
Insect eggs	10		

were found by working behind flocks and checking fresh scratchings; by looking along paths in wooded areas and around water holes on logging roads frequented by turkeys; and in dry ox-bow lake beds and on sand bars.

The analysis of food materials was computed on a frequency of occurrence basis by habitat and period. Food items occurring in less than 10 per cent of the droppings, crops and gizzards in any series are not listed in this report (Tables 1–3).

Summary

A knowledge of turkey foods in the White River bottoms of southeastern Arkansas was obtained by an analysis of 1026 droppings and 22 crops and gizzards collected from various habitats during the period 1950–1955. Acorns, sugarberries, pecans, poison ivy fruit, blackberries and blades of grass were important foods in the first bottoms; seeds of crabgrass dominated droppings collected from sand bars in summer and fall; while in dry ox-bow lake beds, feathergrass seeds were the principal food in the fall, and styrax fruit in the summer.

Acknowledgments

The writer is indebted to Fish and Wildlife Service co-workers A. C. Martin and Johnson A. Neff for the identification of several food items, and to co-workers Charles C. Sperry, Vincent H. Reid and Peter J. Van Huizen for reviewing the manuscript. Anna Gilkeson Meanley assisted in the field work.

U.S. Fish and Wildlife Service, Alexandria, Louisiana, November 15, 1955

NEW LIFE MEMBER

Albert Schnitzer, a native of New Jersey, graduated from New York University in 1934. After teaching mathematics for a short time, he entered business and now runs a plant which specializes in stainless steel machinings. He married Eva Feder of Perth Amboy, New Jersey, with whom he shares a lively interest in the natural sciences. A bander for the past five years, he is shown here among his traps at his home at Elizabeth, New Jersey, where this March he and his wife banded 259 redpolls. His hobbies include botany and photography, and he has travelled extensively in Central America, South America, and in the Caribbean.

TWO PHYSIOLOGICAL CONSIDERATIONS IN BIRD MIGRATION

BY W. B. YAPP

THE crossing of large expanses of sea by migrant birds has been known from time immemorial, and journeys of several hundred miles, such as those over the Mediterranean, over the North Sea from Europe to Great Britain, and over the Caribbean Sea, are commonplace. More recently it has become generally admitted that even the Atlantic is crossed quite often, even if not regularly. The evidence for Atlantic crossings from west to east has been reviewed by Alexander and Fitter (1955) and since their paper was published, the magazine *British Birds* has contained five new records of North American birds in Great Britain. The navigation which enables long sea crossings to be made, and the muscular and respiratory physiology which permits long flights to be sustained, are obviously of great interest. There is very little experimental evidence on either of these matters, and my purpose in this paper is to try to apply what little we do know, necessarily in a theoretical way, to the problem.

Williamson (1952 and 1954) has shown from a study of the weather maps that the most marked migration into Great Britain from northern Europe occurs in meteorological conditions which produce a steady east wind, and that the notable invasions of American birds occur with west winds. From these observations he has drawn the conclusion that, under conditions of strong wind over the sea, birds abandon their standard direction and fly downwind, so that they are brought more quickly to land. Clearly a strong wind, especially a cross wind, must have great effects on migrating birds, but for us to be able to assume that this particular type of reaction to cross winds always or generally occurs, we must be able to show, following current evolutionary theory, that it has such advantages over all other types of reaction that its production by natural selection is probable. The possibilities have never, so far as I know, been fully considered.

In the discussion which follows I use terms in the sense which they have in dynamics and air navigation. "Speed" is rate of change of position, that is, distance traveled per unit of time; "velocity" is speed in a particular direction, so that it is a vector; "course" is the direction in which the bird propels itself through the air; "track" is the line over the land which it follows as a result of its flight and of the wind, that is the resultant of its own velocity and that of the wind.

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Dr. G. W. Salt for reading a draft of this paper or for helpful discussion.

Possible Means of Orientation in Overseas Flights

A bird out of sight of land and subject to a cross wind may do one of four things.

1. If it can continue to orient itself, it may continue flying in its standard direction, that is, on the course which has been laid down for the species in the past, presumably by natural selection. In daylight it determines this by some navigational clues which may include landmarks and the sun; at night, or at least on a dark night in latitudes and seasons where the direction of the sun below the horizon cannot be seen, it would need other means of orientation, but what these may be we do not know. If it does continue to fly in this way, the velocity of the wind must be added to the bird's velocity through the air, and if we know both of these we can find its track by the vector triangle method. To take a simple example, a bird which started to cross the Skaggerak at the south of Norway on a southerly course (180°) and encountered an east wind (90°) with the same speed as its own, would travel on a track of 225° and so arrive on the Yorkshire coast instead of in Denmark. Following the normal navigational usage it is to this type of displacement, and to this only, that the term "drift" should be applied.

2. The bird might, as Williamson suggests, recognize from the appearance of the sea the direction of the wind, abandon its standard direction, and reorient itself so as to fly downwind. I am informed that wind-lanes, which would seem to be the most likely clue by which the bird could determine the direction of the wind when out of sight of land, are only formed at speeds above Beaufort Force 4 (minimum speed 13 m.p.h.). The direction of movement of waves is an unreliable guide, since it may persist long after the wind has died down.

3. It would seem, however, that if the bird could tell the direction of the wind it might also be able to determine the relation of this to its own standard direction, and so be able to maintain the latter approximately by flying at the necessary angle to the wind. This would be comparable to normal air navigation, in which the course of the aircraft is calculated so that the vector triangle of the course plus the wind gives the required track.

4. If it had no navigational clues, and were unable to determine either its standard direction or that of the wind, the bird might continue to fly in what, to use anthropomorphic language, appeared to it to be the direction in which it started. I know of no experiments on this sort of blind flying, but for human beings walking, swimming and driving an automobile, the result of trying to keep a straight course with the eyes shut is in fact a large open curve, which approximates to a circle, and it is likely that the same would be true of a bird in flight. A bird doing this would still be

subject to drift. If the radius of the curve were large, the resultant track would be approximately the same as in 1 (derived from the bird's velocity and that of the wind). If the radius of the curve were relatively small, the track would be effectively that of the wind. The point of arrival on land would be the same as in 2 (changing course to fly downwind); the bird would, however, take longer to get there, for while in 2 its ground speed is the sum of that of the wind and its own air speed, in 4 it is that of the wind alone, since it spends as much time flying against the wind as with it. The same result would be given if the bird frequently changed its course. If the radius of the curve were of the same order of magnitude as the length of the sea crossing, the track of the bird would be effectively random.

Of these possibilities, 4 would clearly be disadvantageous and it would seem that a moderate radius of the curve in which the bird flies would be the worst. 1, 2 and 3, if the wind were in any degree a following wind, would all take the bird across the sea, but the points of arrival would be different. If the arrival coast were straight and ran at right angles to the bird's standard direction, the shortest crossing in terms of time would be made by 1 and the longest by 2, but if the coast were irregular and had bays and promontories, either 1 or 2 or 3 might bring the bird more quickly to land, according to the particular configuration of the land and the velocity of the wind. Condition 2 is likely usually to take longer than 3 and would only not do so if a high-speed wind happened to take the bird to a promontory which jutted far out from the coast. With so much variation it seems unlikely that natural selection could in any way discriminate among these three different types of flight. If 1 (maintenance of standard direction) is ruled out as improbable, it still remains true that 2 (flying downwind) would seldom be more advantageous than 3 (determining course from wind direction). Only if it were consistently so would Williamson's hypothesis of its choice by natural selection be possible. Since 4 (attempting to maintain a straight course without clues), though the worst of the four reactions, might be expected to lead to a large number of successful crossings and demands no special abilities in the bird, it is the one which for the present, on the principle of economy of hypothesis, ought to be accepted.

Some Energy Relations of Overseas Flights

At the end of a long sea crossing migrant birds are often exhausted, and it would be interesting to know from what sort of fatigue they are suffering and how near to every possible physiological limit they have gone. Williamson (1952) has reported that a number of birds weighed as they arrived at Fair Isle, off the east coast of Scotland, were lighter than the same species at the same time of year trapped at Lista in Norway. While it is interesting

that a loss in weight is probably demonstrable by weighing small numbers of trapped birds (though measuring such a variable quantity as the mass of a bird to four significant figures represents misplaced zeal), it would be more interesting still to know in what the loss consists and how near it goes in an average sea crossing to the theoretical and practical limit. The first of these, on which the second depends, could be determined only by chemical analyses of the bodies of migrating birds before and after their journey, but the following calculation, though approximate, may suggest the order of magnitude of the loss which might be expected.

There are several types of flapping flight, but it seems that in general in fast and moderately fast flight the up-stroke is passive, and this is true also of small birds in slow flight (see Brown, 1953, and the same author reported anonymously in *Nature*, 1955). Such flight means that the bird must fall during the up-stroke and rise again during the down-stroke, and it is easy to calculate the energy expended by the bird in maintaining itself in the air in this way. If any lift is contributed by the upstroke of the wings, as happens in larger birds in slow flight, there is a greater mechanical efficiency and less energy is needed.

Let the weight of the bird be x gms. weight, and let there be n wing beats per second. If downstroke and upstroke are of equal duration (as Brown, 1953, has shown to be true of the gull in fast flight) between two successive downstrokes the bird falls a distance

$$d = \tfrac{1}{2} \times \frac{g}{4n^2} \text{ cms.}$$

The work done during the upstroke to raise it again, is

$$f \times d = \frac{xg^2}{8n^2} \text{ ergs,}$$

and work done per second is

$$\frac{xg^2}{8n} \text{ ergs.}$$

The work done per hour is

$$\frac{3600xg^2}{4.2 \times 10^7 \times 8n} \text{ cals.}$$

This energy might be provided by the combustion of carbohydrate (probably chiefly glycogen) or of fat. Different carbohydrates have slightly different energy values (Benedict and Fox, 1925), but an average value seems to be 4100 calories per gram. I have not been able to find any figures for the efficiency of avian muscle, but the maximum for frog muscle is about 20 per cent and that for human muscle 22 per cent (Hill, 1939). In view

of the closeness of these two figures for rather widely separated vertebrates, it is unlikely that bird muscle is greatly different. The efficiency depends on the speed of contraction of the muscle, and falls off fairly rapidly on each side of the optimum. It is unlikely that the bird can maintain the optimum steadily for very long periods, however much it may approximate to a steady rate of wing-beat. There is also a loss of energy because the aerodynamic efficiency of the wing-stroke is less than 100 per cent, although it seems impossible to calculate this (Brown, 1955). Further, some energy is needed to overcome air-resistance, although at speeds of up to about 30 m.p.h. this is likely to be small in comparison with that needed to maintain the bird in the air. It would seem to be safe, in trying to calculate the maximum amount of food material used in flight, to take all these points into account by giving the wing an over-all efficiency of half its maximum, or 10 per cent. The work done per hour therefore represents the consumption of

$$\frac{3600xg^2}{4.2 \times 10^7 \times 410 \times 8n} \text{ gms. carbohydrate.}$$

Meinertzhagen (1955) has recently published figures for the rate of wing-beat of many species. For small and medium sized birds 5 beats per second seems to be a fair average value to take for cruising speed. Meinertzhagen contends that birds on migration fly much faster than usual, so that a value of $n = 10$ would not be far wrong, but if we take the lower value we shall get a maximum consumption of the food stores.

If $n = 5$, the carbohydrate consumed $= 0.00503x$ gms., that is, 0.5 per cent of the mass of the bird is used up per hour. If the chief source of energy is fat, as has been claimed for the House Sparrow (*Passer domesticus*) by Kendeigh (1944), and as appears likely from the well-known deposition of fat prior to migration (see, for instance, Odum and Perkinson, 1951), the loss will be less. One gram of fat produces 9,500 cals. (Benedict and Fox, 1925), so that the work done per hour represents

$$\frac{3600xg^2}{4.2 \times 10^7 \times 950 \times 8n} \text{ gms. fat.}$$

If $n = 5$ as before, this $= 0.00217x$ gms., that is, 0.2 per cent of the mass of the bird is used up per hour.

Energy is also required for the maintenance of body temperature. Kendeigh (1944) has shown that in the House Sparrow this is, at 10°C external temperature, approximately $35x$ calories per hour, where x as before is the body weight in grams, which represents $0.0085x$ gm. of carbohydrate or $0.0037x$ gm. of fat. A small bird therefore uses its reserves nearly twice as rapidly to maintain its temperature as for flight. Since our figures for energy consumption have been maxima throughout, and since the air tempera-

ture will often be less than 10°C, this factor will almost certainly be exceeded as a rule. Most of the waste energy of the muscular contraction (we have taken this to be between 80 and 90 per cent) will be available for maintaining the temperature, and the total loss of reserve material appears to be of the order of 1 per cent of body weight per hour if it is carbohydrate, or 0.4 per cent per hour if it is fat.

If a bird crosses the North Sea from the Skaggerak to Fair Isle at an air speed of 30 m.p.h. with a following wind of 20 m.p.h., its ground speed will be 50 m.p.h., and its flight will take approximately six hours, so that it will lose some 6 per cent or 2.4 per cent of its mass according to whether it uses carbohydrate or fat. Williamson's experimental figures suggest that the loss is, in fact, more like 10 per cent. There are two possible sources of this extra loss. The bird may defecate during its crossing, and if we assume that it starts its flight immediately after feeding it certainly will do so, and it will lose water from the lungs and air sacs. Kendeigh found the total loss of moisture from his House Sparrows to be $0.005x$ gms. per hour for birds at rest at 10°C external temperature. This is approximately one and a half times the loss by combustion of fat under the same conditions, and, as in the combustion of fat the oxygen taken in very nearly balances the carbon dioxide given out, means that the bird is losing stored water over and above the metabolic water which represents the loss of oxidized material. Dawson (1954), who worked on the Brown and Abert towhees (*Pipilo fuscus* and *P. aberti*) found that at 39.5°C the birds drank more water than, as shown in a parallel experiment, they lost by evaporation. In flight, the evaporation of water will presumably be greater than when the bird is at rest, but by how much we do not know. If it rose to the level which both Kendeigh and Dawson found for birds at rest at an air temperature of 40°C, the loss for a six-hour flight would be about 10 per cent. Williamson's figures therefore appear to be remarkably close to the best theoretical forecast that one can make. (The evaporation of the water of course needs energy; for a loss of 0.015 gm. per hour it would be 8.6 cal. per hour. There is no means of telling how much of this has already been included in Kendeigh's figure of $35x$ cal. per hour for heat maintenance, but some of it will have been so included, and the addition of the rest does not greatly affect the magnitude of our result.)

If my interpretation is correct, the limits of a long flight may well be set by thirst rather than by hunger. Williamson (1954) has contended that on such flights, as for example in the west to east crossings of the Atlantic, it is a positive disadvantage for a bird to rest on a ship. The basis of this contention is that the bird will, if it flies on with a following wind, just about have exhausted its food reserves when it lands, so that anything which delays

landfall is likely to be fatal unless food can be picked up during the rest. Even if for most of the species of birds concerned little food is likely to be available on board ship, water, in the form of dew or rain, will often be present, and a rest may therefore be very helpful to a bird suffering from thirst.

Odum and Perkinson (1951) have shown that the body-weight of White-throated Sparrows (*Zonotrichia albicollis*) is about 20 per cent less in October and November (after migration) than it is in April and May (before migration) and that almost all this loss is of fat. These birds have not made a long sea-crossing and presumably are not near exhaustion, so that larger losses could be borne before death would occur. We do not know how rapidly the fat can be metabolized. Wigglesworth (1949) found that when fruit flies (*Drosophila*) were flown to exhaustion, they could fly again, either after a rest with no food, or almost immediately after being given soluble carbohydrates. The period of flight following a rest (but before exhaustion again set in) was longer the longer the rest; after an hour it was about one-sixtieth of the duration of the previous flight. These observations agreed with analyses of the body composition which showed that during flight fat did not disappear. Presumably it was converted to carbohydrate, and so made available during the rest.

It is possible that the chemistry of bird flight might be similar, although it would be dangerous to argue from insects to birds without experiment. If it were, a rest on a ship would allow an exhausted migrant to change stored fat into carbohydrate, and so allow it to recover and fly further, quite apart from the provision of food or water. The muscular physiology of birds, although little is known about it, is unlikely to differ in principle from that of frogs and mammals. Here there are several sources of fatigue: chemical substances other than carbohydrate may fail, there may be too great an accumulation of lactic acid, the nerve-muscle junction may cease to act, or the central nervous coordination may be upset. Fatigue due to some of these may be abolished merely by rest, as happens especially in human sleep. To determine the chief cause of the fatigue of arriving migrants would need experimental work, but much might be learned by observation of the conditions under which they recover. Until more is known it cannot be assumed that a rest on a ship is harmful.

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DEPARTMENT OF ZOOLOGY AND COMPARATIVE PHYSIOLOGY, UNIVERSITY OF BIRMINGHAM, BIRMINGHAM, ENGLAND, JANUARY 11, 1956

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GENERAL NOTES

Cape May Warbler in Oklahoma.—On May 7, 1955, in heavily-wooded bottom land of the Caney River, four miles north of Collinsville, Tulsa County, Oklahoma, L. Ray Bunch and I collected a male Cape May Warbler (*Dendroica tigrina*), apparently the first specimen for this state. The bird was singing and feeding industriously among the lower branches of a large pecan tree about 25 feet from the ground. With it were a male Myrtle Warbler (*Dendroica coronata*) and a male Yellow Warbler (*Dendroica petechia*). We saw no other Cape May Warbler. The specimen, now no. 2160 in the collection of the University of Oklahoma Museum of Zoology, was in full breeding plumage. It was very fat and its testes were enlarged (3 × 3.5 mm.). Dr. George M. Sutton verified our identification.

Nice and Nice (1924. *Univ. Okla. Stud.* No. 286:114), list the Cape May Warbler among those birds not reported in Oklahoma, but whose appearance is to be expected. Later, Nice (1931. *Publ. Univ. Okla. Biol. Surv.*, 3 [1]), in the last complete listing of the birds of this state does not mention the Cape May Warbler, nor is it shown in her list of additions to the 1931 publication (Nice, 1944. *Proc. Okla. Acad. Sci.*, 24:14–15). In the literature published since the latter date, I have found only one record of this bird being observed here. One was seen by R. C. Brummet in the Quartz Mountain State Park of Greer County and was reported by Baumgartner (1951. *Audubon Field Notes*, 5:264).—John S. Tomer, *4045 E. 27th St., Tulsa, Oklahoma, August 29, 1955.*

Black Ducks eat stunned fish.—A power generation plant on the shore of Lake Erie near Erie, Michigan, discharges its cooling water directly into the lake. On the morning of January 23, 1955, a cold, brisk wind was driving the warm discharge water out into the lake through a gap in the ice. Near the gap some 700 ducks, mostly Black Ducks (*Anas rubripes*), rested while nearer shore in a small cove of open water about 40 others were feeding.

In addition to the Black Ducks, the small group included single Mallard (*Anas platyrhynchos*) and Scaup (probably *Aythya marila*) males and single Canvasback (*Aythya valisineria*) and Pintail (*Anas acuta*) females and two Goldeneye (*Bucephala clangula*) females. The Goldeneyes and Canvasback were diving; the Scaup floated idly; but the Black Ducks were busy taking and eating small fish about three inches long which they seemed to be finding just below the surface.

F. H. Kortright (1942. "The Ducks, Geese and Swans of North America," page 167), reporting the results of the examination of the stomachs of 390 Black Ducks, lists approximately 1 per cent of the content as fishes. In contrast, Milton B. Trautman (1940. "The Birds of Buckeye Lake, Ohio," page 178) reports that Black Ducks ". . . ate gizzard shad with . . . avidity . . ." and refers to their ". . . picking up and swallowing the benumbed and recently killed shad."

It seems likely that the ducks I observed were harvesting fish that had been stunned or killed by the hot discharge water. Although fish may not be a normal food for Black Ducks, this observation seems to confirm that they have no aversion to it and will eat fish in quantity when the taking is made easy.—John M. McCormick, *1827 Richards Road, Toledo 7, Ohio, October 5, 1955.*

Comments concerning the age at which imprinting occurs.—It should be called to the attention of workers in the field of ethology that many of the differences that have been reported in the age at which imprinting most readily occurs could be the consequence of inbreeding. In wild precocial birds, such as ducks and geese, the

phenomenon of imprinting is of great adaptive value, ensuring, as it does, that the young will respond properly to the parent at the same time at which they are physically capable of dispersal. Among altricial birds, needless to say, their physical inability to leave the nest makes the same mechanism less important. However, it will also be seen that the ability to be imprinted represents a highly maladaptive trait among domestic ducks and geese, as in such birds there would be a high likelihood of the occurrence of imprinting onto the wrong object. One would thus suspect the ability to be imprinted to be a rather labile trait which could be maintained only in the face of strong selection. As a consequence, inbreeding and domestication, with its concomitant and unnatural reduction of mortality, would tend to produce individuals differing greatly from the parent stock with respect to their imprintability. In this connection, it is well to recall the loss of broodiness in the white races of the domestic fowl (*Gallus gallus*). I would suggest that this could account for the differences in the sensitive periods and success of imprinting reported by several different workers: Fabricius (1951. *Proc. Tenth Internat. Ornith. Congr.*), E. H. Hess (1955. MS), K. Lorenz (1937. *Auk*, 54:245–273), M. M. Nice (1953. *Condor*, 55:33–37), and Ramsay and Hess (1954. *Wilson Bull.*, 66:196–206). —Peter H. Klopfer, *Osborn Zoological Laboratory, Yale University, New Haven, Connecticut, September 28, 1955.*

Little Gull taken in Indiana.—On December 22, 1955, William J. Barmore, Ted Chandik, Richard E. Phillips, and I found an adult Little Gull (*Larus minutus*) feeding with about 20 Bonaparte's Gulls (*Larus philadelphia*) in the harbor at Michigan City, LaPorte County, Indiana. The gulls were feeding among the drifting ice cakes in a relatively open channel. After repeated observations of the Little Gull as close as 10 feet I collected it. This constitutes the first specimen for Indiana (although there are numerous sight records) and evidently one of the few specimens for the United States. It was very fat and weighed 155.5 grams. The sex could not be determined. Two of the three small minnows removed from the gullet were identified by Dr. Reeve M. Bailey, University of Michigan, as *Notropis atherinoides* (Emerald Shiner).

Phillips and I had observed an adult Little Gull at the above place on January 27, 1955, but had been unable to collect it. It fed with an immature female Black-legged Kittiwake (*Rissa tridactyla*), which I collected, and a few Ring-billed Gulls (*Larus delawarensis*), but there were no Bonaparte's Gulls. The previous night the temperature had been at least —10° F. and the gulls were feeding in two small, warm water outlets of the Northern Indiana Public Service Company plant. Except where these outlets flowed into Lake Michigan, no other open water was visible.

The Little Gull skin and partial skeleton are deposited in the University of Michigan Museum of Zoology; the Kittiwake skin has been deposited in the Purdue University Wildlife Laboratory Collection.—Russell E. Mumford, *University of Michigan Museum of Zoology, Ann Arbor, Michigan, January 26, 1956.*

Evening Grosbeak nesting in Michigan.—Actual nesting records of the Evening Grosbeak (*Hesperiphona vespertina*) in Michigan are few. Wood (1951. *Univ. Mich. Mus. Zool. Misc. Publ.* no. 75:456) listed only two, although summer observations of adult birds were recorded from several areas. I would like to thank Dr. Lawrence H. Walkinshaw, who gathered most of the following information, for graciously turning it over to me for publication.

Dale and Marian Zimmerman observed about 50 grosbeaks July 25, 1952, along Highway M-77 at the Alger-Schoolcraft County line, 11 miles north of Seney. These birds were eating the fruits of wild cherry and *Amelanchier*; at least three birds were stub-

tailed young, barely able to fly, being fed by the adults (*Audubon Field Notes*, 6:284). From June 18 to 20, 1953, John and Ruth Bunnell, William A. Dyer, Peter Hovingh, Jr., James Ponshair, Walkinshaw, and the Zimmermans observed 11 to 12 birds per day at this site. The grosbeaks were coming to feed at a salt block behind Rustic Cabins Lodge. Grosbeaks came from the south, southeast, and northwest. Since more males than females were seen, the observers thought perhaps the birds were nesting nearby. These observers also found three male and one female Evening Grosbeak in the Dutch Fred Lake woods, two miles south of the Lodge.

In 1954, Dr. and Mrs. W. Powell Cottrille, Dyer, Vivian Mumford, Walkinshaw, and the writer made their headquarters at Rustic Cabins in late June. We found from five to 15 Evening Grosbeaks utilizing the salt block daily. On June 21, while working through a woods north of Dutch Fred Lake with Powell Cottrille and Walkinshaw, I noticed a rather conspicuous nest high up in a 90-foot sugar maple (*Acer saccharum*). It was found to be occupied and a forked tail projected over the nest rim. After considerable stick throwing, we finally flushed the incubating bird, a female Evening Grosbeak. She called as she flew from the nest. Cottrille climbed the tree on June 24, but was unable to approach closer than about 10 feet from the nest. It was constructed on top of an almost horizontal, slightly ascending, small branch, about eight feet from the trunk of the tree. The four greenish-blue eggs were quite heavily marked with brownish spots and blotches which averaged less than an eighth of an inch in diameter. The nest was 54 feet (measured) above the ground and was rather loosely constructed of twigs and small sticks, which ranged in size from one-sixteenth to one-fourth inch in diameter and from four to six inches in length. Finer twigs composed the lining and the nest was well shaded and mostly covered from above by a clump of leaves. It was still occupied on July 1, when last visited.

From June 14 to July 2, 1955, H. Lewis Batts, Jr., the Bunnells, the Cottrilles, Dyer, Eliot Porter, Josselyn Van Tyne, and Walkinshaw again visited the area. They saw Evening Grosbeaks daily, but found no nests. From these records it appears that the Evening Grosbeak may nest regularly in the region north of Seney.—Russell E. Mumford, *University of Michigan Museum of Zoology, Ann Arbor, Michigan, April 1, 1956.*

The nest and egg of *Tachyphonus phoenicius*.—The Red-shouldered Tanager (*Tachyphonus phoenicius*) is a medium-sized tanager which inhabits the Guianas, northern Brazil, southern Venezuela, and eastern Peru. The male is glossy black on both the upper and under surfaces, and there is a bluish sheen to the upper parts; the upper lesser wing coverts are scarlet and the axillaries and underwing coverts pure white. The female is totally different, the general color of the upper surface being dusky brown, while the throat and middle abdomen are Isabelline white. Ten male specimens which I collected in Surinam average 21.38 grams, and three females weighed 21, 23 and 25 grams, respectively.

I have been unable to find a description of the nest and eggs of this species. The eggs were not listed in the collection of the British Museum (Ogilvie-Grant, 1912. "Catalogue of the Collection of Birds' Eggs in the British Museum," vol. 5), in the Nehrkorn collection (1910. "Katalog der Eiersammlung nebst Beschreibungen der aussereuropäischen Eier." Berlin), or in the Penard collection from Surinam (Hellebrekers, 1942. *Zool. Meded.*, 24:271–272). Neither H. Snethlage (1928. *Jour. f. Orn.*, 76:726–728) or E. Snethlage (1935. *Ibid.*, 83:21) mentions nests or eggs from Brazil.

Zimmer (1945. *Amer. Mus. Nov.* no. 1304:23) stresses the paucity of information concerning the habits of this species. In Surinam *Tachyphonus phoenicius* inhabits rather open, sandy savannas covered with scattered bushes. It is rather common in this

habitat. On February 5, 1956, I flushed a female from a small clump of grass almost beneath my feet in an opening near the edge of a bush in a savanna near Zanderij (about 50 kilometers south of Paramaribo). The nest was on the ground at the edge of the clump and was rather well concealed; it contained a single slightly-incubated egg. The outer layer of the nest was composed of dry, rather broad grass stems and the inner cup was lined with very fine grasses. The nest was 6 cm. wide and its depth was 5 cm.

The egg was chocolate brown at its broad end, and this color was spread in smaller spots and blotches to the narrow end, where the ground color was greyish. The shell was not glossy. The egg measured 20.9 × 14.9 mm.—F. HAVERSCHMIDT, *P. O. Box 644, Paramaribo, Surinam, February 9, 1956.*

FIG. 1. Nest and egg of *Tachyphonus phoenicius*, Zanderij, Surinam, February 5, 1956.

Notes on the nesting of the Wandering Tattler.—The Wandering Tattler (*Heteroscelus incanus*) is a common nesting bird in Mount McKinley National Park, Alaska. During the course of my field work I have frequently encountered the birds along the smaller creeks, sometimes seeing downy young, and on three occasions finding nests. These nests are, so far as I know, the only ones found since the first one was discovered in 1923 (O. J. Murie, 1924. *Auk*, 41:231–237). This first nest was elaborate for a shore bird, but the other three were much simpler, two of them containing practically no nest material, and the fourth composed of barely enough stems to cover the bottom of the depression, and some loosely-laid stems and fine twigs which formed a token rim.

In the finding of the third nest on June 10, 1953, I learned that both birds share in

the incubation of the eggs. On that occasion, I heard a tattler call two or three times near me and saw it on the margin of a gravel apron. Soon it moved slowly, with many stops, out on the gravel, and when it had reached about the middle of the gravel area a second tattler stood up beside it, and shortly flew away. It had been sitting on a clutch of eggs. The first tattler at once settled on the nest.

A further sharing of family responsibilities was observed after the eggs hatched. On the morning of June 29, a cool and cloudy day, I saw one of the parents brooding the young in the nest. The eggs had hatched sometime after I checked the nest on the preceding day. I left the parent undisturbed, and in half an hour returned with a camera. During my absence the family had left the nest, and the young were being brooded on the gravel about 30 yards from it. In a few minutes the tiny chicks scampered forth, and on twinkling feet scattered over the bar, 20 or 30 yards, in various directions in their active search for food. While the young foraged, the parent called at intervals, the calls serving perhaps to circumscribe the wanderings of the babies. The chicks called too, but so faintly and softly that the calls were hardly audible. In about five minutes the parent's calls became a little louder. It was evident that it was summoning the chicks. After a few of these louder calls, the parent squatted on the rocks and called more softly and coaxingly. At least three distinctive, soft calls were given, one of which reminded me of the loud, rolling call one frequently hears along the creeks. The young responded to the calls by feeding toward the parent and finally disappearing underneath her.

About 4:00 p.m. on the day the young left the nest I stopped to watch the tattlers again. Soon the parent in charge of the young called loudly, and walked a few feet away from the young. In a few moments the mate came flying up from the creek bottom and alighted about 20 yards from the rest of the family. It squatted on the rocks and called softly to the young, which responded and were soon brooded. The relieved bird flew down the creek, apparently to feed. Two hours later I again observed a parent take over the brooding task from its mate. The parents did no feeding while in charge of the young.

In the evening the adult with the young moved them from the gravel bar where they were hatched, down a 15-foot embankment grown up in willow brush (*Salix*) to the bars along Igloo Creek, a distance of about 100 yards. In moving the young the parent called loudly for a time from the top of a willow and then from a little spruce tree (*Picea*) part way down the slope. Then it flew down to the bar and called softly, and soon the young arrived.

Two days later the young were foraging actively in the new area. Part of the time they waded in an expanse of shallow water, picking insects off the surface. One chick captured an insect too large to swallow, so carried it ashore to pick apart. While I watched, the young fed for half an hour without being brooded.

On June 12, 1953, three of us flushed a Wandering Tattler from a nest on a bar about 30 feet from a small stream coming down one of the canyons cutting far back into Cathedral Mountain. On June 28 when I visited the nest area I found that a flood a few days earlier had dug a deep channel in the bar where the nest had been. This nest would have been safe from ordinary high water, for it was four or five feet above the surface of the creek, but the rise in the stream on this occasion was unusually high and destructive.—Adolph Murie, *National Park Service, Moose, Wyoming, March 12, 1956.*

Ringed Kingfisher at Austin, Texas.—On November 15, 1955, Eugene S. Tinnin showed me a bird at Barton Springs, Zilker Park, Austin, which I recognized immedi-

ately as a Ringed Kingfisher (*Megaceryle torquata*). I had recently seen this species, as well as all other North and Middle American kingfishers, except *Chloroceryle inda*, numerous times in tropical Mexico and in museum study collections.

At frequent intervals from November 16 through December 11 others familiar with the species in life—William S. Jennings of the Texas Game and Fish Commission, Mr. and Mrs. Fred S. Webster, Jr., and Armand Yramategui—also viewed the bird through binoculars and a 30× telescope at distances ranging from 30 feet to 80 yards.

I asked each person who studied the kingfisher to make his own notes and drawings of it without referring to illustrations or descriptions for aid. Mr. and Mrs. William D. Anderson, Frances J. Gillotti, Emma L. Purcell, and Mr. and Mrs. Fred S. Webster, Jr. complied. A summary of their extensive notes follows. The bird somewhat resembled nearby Belted Kingfishers (*Megaceryle alcyon*) but was larger and had a much heavier bill. Upperparts and chest were blue-gray; the tail was crossed by a number of white bars. Throat, collar, and a narrow band marking the lower border of the chest were white. The remainder of the underparts, including the crissum, was rufous. Webster described the call note as a "rusty *cla-ack* or *wa-ak*." Emma L. Purcell once watched the bird "dive into the water in the same manner as a Belted Kingfisher."

In addition to the fact that fish-eating kingfishers are seldom kept in captivity, the Austin individual showed no signs of having been caged.

The bird seen at Austin appears to be the northernmost Ringed Kingfisher on record. The next most northerly seems to have been one George B. Benners collected on the Rio Grande about one mile downstream from Laredo, Texas, June 2, 1888 (Witmer Stone, 1894. *Auk*, 11:177). Laredo is 219 airline miles southwest of Austin. I find only two other published reports of *Megaceryle torquata* in the United States. At the San Benito Resaca, Texas, 286 miles south of Austin, Luther C. Goldman discovered an individual on March 15, 1953. With C. E. Hudson he saw the bird again on March 19. (1953. *Audubon Field Notes*, 7:224). Lawrence Tabony watched another at Brownsville, Texas, 303 miles south of Austin, on August 29, 1952 (1952. *Audubon Field Notes*, 6:290).

Three of the four Ringed Kingfishers mentioned above were in female plumage; the sex of the individual seen at Brownsville is not stated. Perhaps females wander more often than males. Future observers of extralimital members of the species should note sex differences. Individuals with the rufous of the underparts extending over the chest and with the crissum white, are in adult male plumage.—Edgar B. Kincaid, Jr., *702 Park Place, Austin 5, Texas, March 14, 1956.*

Sandhill Cranes killed by flying into power line.—On March 22, 1954, I was watching Sandhill Cranes (*Grus canadensis*) on the North Platte River, four miles northeast of Hershey, Lincoln County, Nebraska. On the previous day we had counted and estimated 24,038 cranes roosting on a shallow, sandy stretch of river in this area. Most of them left the roost at daylight or shortly afterwards, flying to old cornfields to the south, southeast and southwest. In the evenings, just prior to dark, they flew back to the river, roosting on sand bars or in shallow water.

The morning of March 22 was clear with no fog. At 8:45 a.m. as I drove along an east-west road about one mile south of and parallel to the river where the cranes roosted, I came upon five Sandhill Cranes, all but one dead, lying in and at the south edge of the road. The fifth bird died during the day. A two-wire power line ran east and west 20 feet north of the highway. The wires, both on the same plane, were about 30 feet from the ground. Apparently before it was entirely light, these low-flying cranes

had flown into the power line in passing southward from their roost. They were still warm when I found them. One bird had a wing sheared off; one lost a wing and leg; another lost both legs. All five were saved as specimens. W. E. Eigsti and I examined the stomachs, weighed the birds, froze them and shipped two to Dr. Josselyn Van Tyne, University of Michigan, Museum of Zoology and three to Dr. George H. Lowery, Jr., Louisiana State University.

The stomachs had the following contents: (1) 13 kernels of corn; several weed seeds; some fine gravel. (2) 28 kernels of corn; corn hulls, sand; fine gravel. (3) 8 kernels of corn; corn hulls, weed seeds; coarser gravel. (4) 3 kernels of corn; corn hulls. (5) 5 kernels of corn; many oat hulls; gravel.

Two of the birds were males and three, females. Walter J. Breckenridge spent several days on this same area during late March, 1945. On March 28 he collected ten specimens, five males and five females. The average weight of these seven males was 3936.28 grams (range, 3402–4337) or 8 lbs., 10.8 oz. (7 lbs., 8 oz.–9 lbs., 9 oz.). The eight females averaged 3241.37 grams (2835–3856) or 7 lbs., 2.3 oz. (6 lbs., 4 oz.–8 lbs., 8 oz.).

The wing spans of five males taken by Breckenridge averaged 184.1 cm. (177.8–191.8) and those of six females averaged 168.8 cm. (152.4–182.9).

Thus all 15 specimens, ten collected by Breckenridge on March 28, 1945, and five that I found dead on March 22, 1954, were all Lesser Sandhill Cranes (*Grus canadensis canadensis*).—Lawrence H. Walkinshaw, *1703 Wolverine-Federal Tower, Battle Creek, Michigan, March 1, 1956.*

Lark Sparrow collected in Rhode Island.—On November 12, 1955, at Newport, Newport County, Rhode Island, a Lark Sparrow (*Chondestes grammacus*) was observed feeding with Savannah Sparrows (*Passerculus sandwichensis*) along the edge of a field adjacent to Newport's famed Ocean Drive. Since there was no previous specimen record for Rhode Island, the bird was collected. It was a male with the skull fully ossified; it weighed 31.7 gms. and was very fat. Its apparent good physical condition makes all the more curious the molt that the bird was undergoing.

The feathers over most of the body appeared fresh, but those of the posterior half of this sparrow were found to be in various stages of molt and replacement. The upper tail coverts on the bird's left side were fully grown and were slightly worn and ragged. There was one small feather on this side that was beginning to break out of the sheath. The upper tail coverts on the right side were all sheathed and about one-half grown. Two adjacent rectrices, lying to the right of the central pair, were normal in length but were worn, although not excessively. The remaining rectrices were all about the same length, sheathed and about one-half grown. All of the undertail coverts and many of the contour feathers on the right flank were still in sheaths and about one-half grown. There were fewer sheathed feathers on the left flank.

The specimen (JB no. 146) was identified by Dr. John W. Aldrich as the Eastern Lark Sparrow (*C. g. grammacus*).—James Baird, *Norman Bird Sanctuary, Newport, Rhode Island, March 22, 1956.*

Records of the Buff-breasted Sandpiper from Alabama.—Buff-breasted Sandpipers (*Tryngites subruficollis*) were never collected in Alabama prior to 1955, although H. S. Peters took one near Pensacola, Florida, a short distance east of the Alabama border on September 2, 1936, and T. D. Burleigh took another from Deer Island, Mississippi, a few miles west of the state line, on September 6, 1940. A. H. Howell's "Birds of Alabama," published in 1924, does not list this species as occurring in Alabama. The only known records are those of Henry Stevenson, who noted them near Northport, in

Tuscaloosa County, on September 7 and September 24, 1938, and again near Stroud, in Chambers County, on August 10, 1952.

In the late afternoon of September 14, 1955, Eugene Cypert, E. A. Byford, W. M. Depreast, and the writer were observing shorebird migrants in the Garth Slough vicinity of the Wheeler National Wildlife Refuge. This locality lies some five miles east of Decatur, Alabama, in Morgan County. At that stage of water it consisted of several hundred acres of mud flat, interspersed with channels. Cypert observed five Buff-breasted Sandpipers feeding in short grass on a high portion of mud flat and tentatively identified nine or ten others at a greater distance. Since Thomas A. Imhof was at that time rewriting "Birds of Alabama," and since no specimen was on record for the state, one was collected from the small flock. Later a study skin was prepared and submitted to the U.S. Fish and Wildlife Service; the identification was confirmed by Dr. J. W. Aldrich.

The Garth Slough locality was revisited September 15 but no more of these birds were seen. Byford, on September 23, reported seeing two more in the same vicinity.—THOMAS Z. ATKESON, *Wheeler National Wildlife Refuge, Decatur, Alabama, April 1, 1956.*

The Muscovy Duck in the Pleistocene of Panamá.—During the dry seasons of 1950 and 1951 Dr. C. Lewis Gazin, Curator of Vertebrate Paleontology in the U.S. National Museum, excavated several Pleistocene fossil localities on the Azuero Peninsula on the Pacific side of the Republic of Panamá. In 1951, among abundant remains of ground sloths at El Hatillo, near the highway one and one-half miles west of Pesé, Province of Herrera, he obtained one bone of a bird, the distal two-third of a right ulna (U.S. Nat. Mus. no. 21312). This I have identified as from a Muscovy Duck, *Cairina moschata* (Linnaeus). Dr. Gazin considers the spring deposit from which this bone was obtained as Upper Pleistocene. The bone is stained light brown in color and is somewhat mineralized. It marks the first definite report of an avian fossil from Central America. The Muscovy Duck, well known in domestication, ranges in the wild in suitable habitats in the tropical lowlands from Sinaloa and Tamaulipas in northern México southward along both coasts of Central America and South America to Perú and Argentina. The species is locally common in lagoons and marshes in Panamá today where it is known to hunters as the *pato real.*

Cairina moschata has been found previously in cave deposits of supposed Pleistocene Age in southern Brazil so that it seems to have had an extended range over a long period of time.—ALEXANDER WETMORE, *Smithsonian Institution, Washington 25, D.C., May 3, 1956.*

ORNITHOLOGICAL NEWS

The Wilson Ornithological Society is indebted to Dr. Josselyn Van Tyne for his careful compilation of the list of serial publications in the Society's Library appearing in this issue. It is hoped that the publication of this list will stimulate members to fill out series which are incomplete and will result in increased use of the Library.

The Conservation Department of Cornell University is conducting a research project concerned with hybridization in surface-feeding ducks, including the Mallard, Pintail, Black Duck, Gadwall, Green-winged Teal, Blue-winged Teal, and Shoveller. The purpose of this study is to obtain further information on the relationships within this controversial group, using behavioral data, relative fertility determinations, and possibly other physiological techniques. It is hoped that the greatest possible number of hybrid crosses among these species may be studied, and we are in need of first generation male hybrids of known parentage for this purpose. Any aviculturist who happens to possess such birds, and who is willing to lend them for this project should contact Charles G. Sibley or Paul A. Johnsgard, Department of Conservation, Cornell University, Ithaca, New York.

A new list of sales publications has been compiled by the New York State Museum and is available without charge on request to the Museum at Albany 1, New York. The revised list includes a considerable number of zoological bulletins, circulars, handbooks, etc., that were formerly considered out of print and have been available only through dealers. The stock of some of these items is small; in such cases, preference will be given to orders from libraries of universities, foundations and other organizations.

LETTER TO THE EDITOR

A recent article on distribution of the Dickcissel by Dr. A. O. Gross (1956. *Auk*, 73:66–70) disregards several major contributions to his topic printed in a New York State magazine (Spiker, 1950. *Kingbird*, I (1):6; Stoner, 1951. *Kingbird*, I (2):12; Tabor and Benton, 1951. *Kingbird*, I (3):57). This points once again to the need for more complete recording of available ornithological literature.

Dr. Stratton, editor of the *Zoological Record*, has written to ask that I attempt to persuade editors of such journals to forward copies of their magazines to Col. W. P. C. Tenison, British Museum (Natural History), Cromwell Road, London SW 7, England. They would also be pleased to have copies of back numbers so that the literature contained therein may be recorded.—Gerald R. Rising, Editor, *The Kingbird*

72 Allen's Creek Road
Rochester 18, New York

WILSON SOCIETY LIBRARY

Serial Publications

The serial publications of the Wilson Ornithological Society Library are catalogued, bound, and shelved by the University of Michigan Museum of Zoology in the Bird Division's library rooms. Except for certain rare items that should not be subjected to the risks of transportation, these serials, like the books, are mailed out on request to members of the Society, the University paying postage one way and the borrower paying the return. Some volumes of journals have been completed by combining issues owned by the Society with issues in the University's holdings; a bound volume contributed in part by the Society is, of course, available *in toto* to the Society's members. Secondly, serials contributed to the Society's Library which duplicate serials already owned by the University are usually placed in storage cupboards and separately catalogued; recording of these duplicates is not yet up to date. Thirdly, new gifts of serials are constantly received. Fourthly, some serials are scatteredly represented and appear only in the Library's author catalog. Thus, certain periodicals are more completely available to Members than the following list of the Society's holdings would indicate; and a few titles may be available that are not represented in the list. Members should send inquiries to the Library about their needs; when a particular reference is required, it is well to give it in full, since the Library may have a reprint or a "tear-sheet" of the reference listed under author. Members with serials available as gifts to the Library are requested to state whether these may be exchanged or sold by the Library should they prove to be "surplus duplicates" (i.e., not needed as replacements for worn, damaged, or lost copies).

All serials currently received are indicated in the list by dots following a date and serial number. Unless otherwise stated, such titles are complete to date from the issue specified. Degrees of completeness of series are roughly represented by "scattered," "in part," "incomplete."

Acta Zoologica Fennica (Bird Papers). 1927, No.3. . . .

Agassiz Association. *See* Swiss Cross

A[gassiz] A[ssociation] Bulletin. 1890–1891, Vols.1–2, in part

Agassiz [Association] Journal. 1885, Vol. I, in part

Agassiz Bulletin. 1885, one issue

Agassiz Chapter. 1886, 2 issues

Agassiz Companion ("Literary Companion" *and* "Agassiz Record"). 1886–1890, scattered issues

Agassiz Notes. 1885–1886, Vol.1, in part

Agassiz Record. *See* Agassiz Companion

Agassiz Record (Iowa). 1888, Vol.1, in part

Alauda. 1947, Vol.15. . . . (+)

Amateur Naturalist. 1904–1908, Vols.1–4, in part

American Biology Teacher. 1938–1941, Vols.1–4

American Bird-House Journal. Scattered Issues

American Falconer. 1942–1944, Vols.1–2

American Game Conference, Transactions. 1934, 20th

American Magazine of Natural Science. Scattered issues

American Midland Naturalist. 1940, Vol. 23. . . . (+)

American Museum of Natural History, Bulletin (Bird Papers). 1949, Vol.93. . . . (+)

American Museum Novitiates (Bird Papers). 1949, No.1395. . . . (+)

American Naturalist. Scattered issues

American Ornithology. 1901–1906, Vols. 1–6, in part

American Osprey. 1890, Vol.1 (complete set)

American Pigeon Journal. 1947, one issue

American Society of Curio Collectors, Yearbook. 1909

American Zoologist and Home Journal of Science. 1896, 2 issues

Animal Behaviour. *See* Bulletin of Animal Behaviour

Animal Kingdom. 1946. . . . (incomplete)
Apteryx. 1905, Vol.1, Nos.1–2
Aquila. 1943, Vol.50. . . . (+)
Archives suisses d'ornithologie. 1941, Vol. 1. . . .
Ardea. 1931, Vol.20. . . .
Ardeola. 1954, Vol.1. . . .
Atlantic Naturalist. (*formerly* Wood Thrush). 1945, Vol.1. . . .
Atlantic Slope Naturalist. 1903, Vol.1, in part
Audubon Bulletin. *See* Illinois Audubon Society
Audubon Field Notes. 1947, Vol.1. . . .
Audubon Magazine (Forest and Stream Publ. Co.). 1887–1888, Vol.1, in part
Audubon Magazine (*formerly* Bird-Lore). 1939. . . . (+)
Audubon Warbler. 1941, Vol.4. . . . (incomplete)
Auk. 1939, Vol.56. . . . (+). (*Plus* Bulletin Nuttall Ornithological Club, 1876–1883, complete.)
Aus der Heimat. 1936, 2 issues
Avicultural Magazine. 1946, Vol.52. . . .
Aviculture (*now merged with* Avicultural Magazine). Scattered issues
Avifauna. 1895, Vol.1, Nos.1–2
Battle Creek Nature News. 1931, one issue
Bayern. *See* Ornithologischen Gesellschaft
Bay State Oologist. 1888, Vol.1, in part
Bear Hill Advertiser. 1903, 2 issues
Beiträge zur Fortpflanzungsbiologie der Vögel. 1929, Vol.5. . . .
Beringer und Freunde der Schweiz, Vogelwarte Sempach, Mitteilungen. 1938–1939, Heft 1–2
Biological Leaflet. 1933, No.1. . . .
Biological Society of Washington, Proceedings (Bird Papers). Scattered issues
Biologische Abhandlungen. 1952, No.1. . . .
Bird-Banding. 1930, Vol.1. . . . (incomplete). (*See also* Northeastern Bird-Banding Association, Bulletin.)
Bird Banding Notes. 1922, No.2. . . . (incomplete)
Bird-Lore. *See* Audubon Magazine
Bird-Lovers' League Magazine. 1935, 3 issues
Bird News (California). 1909, Vol.1, in part
Bird News for the School (*later* "Bird News," publ. by Brookline Bird Club). 1942, 3 issues
Bird Study. 1954, Vol.1. . . .
Bird Survey of the Detroit Region. *See* Detroit Audubon Society
Birds and Nature [*with varying title*]. 1897–1916, in part
Birds of Long Island. 1939–1950, in part
Bittern (Maine). 1890–1891, Vol.1, in part
Bittern (Iowa). 1901, Vol.1, No.1
Bluebird (Missouri Audubon Society). 1939–1950, in part
Blue Bird ("Junior Audubon Monthly"; *later* "Nature and Culture" *and various titles*). 1914–1920, scattered issues
Blue-Jay. 1942, Vol.1. . . .
Bokmakierie. 1950, Vol.3. . . .
Bologna, Università, Istituto Zoologico, Ricerche di Zoologia Applicata alla Caccia. 1930, No.1. . . .
Bologna, Università, Laboratorio di Zoologia Applicata alla Caccia, Supplemento alle Ricerche di Zoologia Applicata alla Caccia. 1949, Vol.2. . . .
Bonner Zoologische Beiträge. 1950, Vol. 1. . . .
Boston Society of Natural History, Occasional Papers. 1904–1941, scattered issues
Boston Society of Natural History, Bulletin. 1915–1936, scattered issues
Bowdoin Scientific Station, Annual Report and Bulletin. 1936, No.1. . . .
British Birds. 1946, Vol.39. . . . (+)
British Columbia, Provincial Museum of Natural History Report for 1914
British Ornithologists' Club, Bulletin. 1945, Vol.66. . . .
British Trust for Ornithology. Various publications
Brodie Club, Proceedings. 1937, No.1. . . .
Brookline Bird Club. *See* Bird News for the School
Buckeye State Collector. 1887, 2 issues
Bulletin of Animal Behaviour. 1938–1951 (complete set, except for the rare No. 4)
Bulletin Ornithologique. 1956, Vol.1, No.1
Buzzard. 1926–1927, Vol.1

Califor Naturalist Club, Bulletin. 1916, Vol. 1, No.1

California Academy of Science Proceedings. 1900–1926, scattered issues

California Art and Nature. 1901–1902, in part

California Traveller and Naturalist (*later* Traveller and Naturalist). 1892–1893, in part

California, University of, Publications in Zoology (Bird Papers). Listed under author in W.O.S. Library Book List

Call-Notes (*formerly* Huntington Chat). 1950, one issue

Canada, Provancher Society of Natural History. *See* Provancher Society of Natural History

Canadian Alpine Journal. 1912, one issue

Canadian Field-Naturalist (*formerly* Ottawa Naturalist). Scattered issues

Canadian Sportsman and Naturalist. 1881–1883, Vols.1–3, in part

Cardinal. 1927–1943 (incomplete)

Carolina Bird Club. *See* Chat

Cassinia. 1890, No.1. . . .

Československý Ornitholog. 1936–1948, Vols.3–15 (incomplete)

Chat (North Carolina Bird Club; Carolina Bird Club). 1937, Vol. 1. . . .

Chicago Academy of Sciences, Bulletin of the Natural History Survey. 1907, No.6

Chicago Natural History Museum (*formerly* Field Museum of Natural History). Zoological Series. 1896. . . . (being completed by member of the Society). *See also* Fieldiana.

Chicago Naturalist. 3 issues.

Cleveland Academy of Natural Science, Proceedings. 1874

Cleveland Bird Club. Various publications

Cleveland Museum of Natural History, Scientific Publications. Two issues

Club van Nederlandsche Vogelkundigen, Orgaan. *See* Limosa

Collector (*formerly* Young Collector; Des Moines). 1881–1882, in part

Collector (Pekin, Illinois). 1893, Vol.1, in part

Collectors' Journal. 1901, one issue

Collectors' Monthly (California). 1911, 3 issues

Collectors' Monthly (Connecticut). 1890–1892, in part

Collectors' Monthly (New York). *See* Natural History, New York

Collector's Monthly (Philadelphia). 1886, Vol.1, No.1

Collectors Note Book. 1904–1905, in part

Collectors' Standard. *See* The Mohawk Standard

Collectors' Star. 1888, No.2

Colorado Museum of Natural History, Proceedings. One issue

Columba. 1951, one issue

Comparative Oology. *See* Santa Barbara, California, Journal of Museum of Comparative Oology

Condor. 1940, Vol.42. . . .

Conservación en las Americas. *See* Pan American Union

Conservation, Miscellaneous pamphlets and periodicals on the subject

Contributions to North American Ornithology. 1901–1904, Vol.1, in part

Cooper Ornithological Club, Bulletin. *See* Condor

Curio. 1890, one issue

Curio Bulletin (*formerly* Curio Collector). 1910–1914, in part

Curio Collector. *See* Curio Bulletin

Curio Exchange. 1900–1901, in part

Curio Informant. 1889, Vol.1, No.1

Curiosity Collector. 1889, one issue

Curlew (*predecessor of* Wilson Bulletin). 1888–1889 (complete set)

Danish Review of Game Biology. 1945, Vol. 1. . . .

Danske-fugle. 1920–1937, Vols.1–4 (complete?)

Dansk Ornithologisk Forenings Tidsskrift. 1946, Vol.40. . . . (+)

Danske Vildtundersøgelser. 1953, Part 1. . . .

Delaware Valley Ornithological Club. *See* Cassinia

Delta Waterfowl Research Station. Various publications

Detroit Audubon Society, Bird Survey of the Detroit Region. 1945 [No.1]. . . . (Also various publications)

Dickcissel (*formerly* Sioux City Bird Study Club Review). 1934, Vol.1. . . . (in part)
Duckological (Ducks Unlimited, Canada). Publications, 1938. . . .
Eastern Bird Banding Association, Bulletin. 1941–1947, Vols.4–10, in part
Ecological Society of America, Bulletin. 1943, 3 issues
Edward Grey Institute of Field Ornithology. Various publications
Elepaio. 1946, Vol.6. . . .
El Paso Bird Study Club. *See* Roadrunner
Emergency Conservation Committee. Various publications, 1929. . . .
Empire State Exchange. 1889–1892 (incomplete)
Emu. 1942, Vol.42. . . . (+)
Essex County Ornithological Club, Bulletin. 1921, one issue
Evening Grosbeak Survey News. 1950, No. 1. . . .
Exchange (Illinois). 1889, Vol.1
Exchange (Michigan). 1885, one issue
Exchangers' Aid (*later* Exchanger and Collector). 1885, 2 issues
Exchangers' Monthly (*later* Mineralogist's Monthly). 1885–1890, Vols.1–5
Fair Isle Bird Observatory. Various publications, 1950. . . .
Falconry News and Notes. 1953, Vol.1. . . .
Falke, Der. 1954, Vol.1. . . . (incomplete)
Fauna och Flora. 1951. . . .
Feathers. 1939, Vol.1. . . .
Federal Aid in Wildlife Restoration. *See* Pittman-Robertson Program
Federation of Ontario Naturalists, Bulletin. 1954, No.66. . . .
Field and Forest. 1875–1878, Vols.1–3, in part
Field Museum of Natural History. *See* Chicago Natural History Museum *and* Fieldiana
Fieldiana (Zoology). 1945, Vol.31. . . .
Field Ornithology. 1938–1941, Vols.1–3
Fish and Wildlife Service. Various publications
Flicker. 1937, Vol.9. . . . (+)
Florida Audubon Bulletin. *See* Florida Naturalist
Florida Game and Fish. 1940–1947, Vols. 1–4
Florida Naturalist (*formerly* Florida Audubon Bulletin). 1946, Vol.20. . . . (+)
Flying Feathers. *See* Ohio Cardinal
Forest and Field. 1892, Vol.1
Forest and Stream. 1921–1923, in part. (Only issues containing important ornithological material can be shelved in the Library.)
France, Société Ornithologique de, Mémoires. 1953, No.5, Pt.1. . . .
Gameland. 1894–1896, 2 issues
Game-Research papers. *See* Riistatieteellisiä Julkaisuja
Game Research News Letter (University of Wisconsin). 1937, No.12
Garner and Naturalists' Gazette. 1891, in part
Genève, Bulletin de la Société Zoologique de. 1907–1932, Vols. 1–4
Georgia Ornithological Society, Occasional Publications. 1938, No.1. . . . (*See also* Oriole.)
Gerfaut, Le. 1931, Vol.21. . . . (incomplete)
Gleanings from Nature. Scattered issues
Golden State Scientist. 1886, Vol.1, No.1
Goshawk. 1948, Vol.1. . . . (incomplete)
Göteborgs Museum, Årstryck. 1930. . . . (incomplete)
Grant Cook Bird Club, Youngstown, O. *See* Ohio Cardinal
Guide to Nature. Scattered issues
Gull. 1940, Vol.22. . . . (+)
Harvard, Museum of Comparative Zoology, Bulletin. 1940. . . . (+)
Hawaiian Naturalist. 1944, Vol.1, Nos.1–2
Hawk and Owl Society, Bulletin. 1932–1935, Vols.1–5 (complete set)
Hawk Mountain Sanctuary Association, Annual Report. 1938, No.1. . . . ; *also* miscellaneous publications
Hawkeye Ornithologist and Oologist. 1888–1889, Vols.1–2, in part
Heron. 1930, 1932, Nos. 1–2 (complete set)
Hobby Reporter. 1942, 2 issues
Hoosier Naturalist. *See* Kansas City Scientist
Hornero, El. 1935, Vol.6. . . .
Hummer. 1899, Vol.1, in part

Humming Bird. 1891, Vol.1, No.1

Hunting and Fishing. 1937, one issue

Huntington Chat. *See* Call Notes

Ibis. 1933. . . . (+)

Illinois Audubon Society, Audubon Bulletin. 1916, No.1. . . .

Illinois Natural History Survey. Various publications

Illinois State Academy of Science, Transactions. 1942

Indiana Academy of Science, Proceedings. 1894–1895

Indiana Audubon Society, Mary Gray Bird Sanctuary Bulletin. 1946, No.1

Indiana Audubon [Bulletin *and*] Year Book [*later* Quarterly]. 1920, No.1. . . . (incomplete)

Ink Spot. *See* Ornilore

Inland Bird Banding News. 1940, Vol.12 . . . . (+)

Intermediate Naturalist. *See* Ontario Field Biologist

International Committee for Bird Protection [*and* Preservation], Bulletin. 1927–1935, Nos.1–4

International Office for the Protection of Nature, Report. 1947

International Ornithological Congress, Proceedings. 10th, 11th (for 1950, 1954)

Iowa Academy of Science(s), Proceedings. 1894, Vol.2. . . .

Iowa Bird Life (*formerly* Iowa Ornithologists' Union Bulletin). 1931, Vol.1. . . .

Iowa Cooperative Wildlife Research Unit, Quarterly Report. 1941–1948, in part

Iowa Ornithologist (*later* Western Ornithologist). 1894–1900, Vols.1–5 (incomplete)

Iowa Ornithologists' Union Bulletin. *See* Iowa Bird Life

Iowa, University, Service Bulletin. 1923–1926, in part

Iowa, University, Bulletin from the Laboratories of Natural History (*later* Studies in Natural History). 1888, Vol.1. . . . (incomplete)

Irena. 1941, Nos.1, 2 (complete set)

Jack-Pine Warbler. 1927, Vol.5. . . . (incomplete)

Jacobs, J. Warren. *See* Gleanings from Nature

Journal für Ornithologie. 1932. . . . (incomplete)

Journal of the Museum of Comparative Oology. *See* Santa Barbara, California

Junior Division of the Detroit Audubon Society, Bulletin. *See* Detroit Audubon Society

Kansas Academy of Science, Transactions. Vol.1, 1872. . . .

Kansas City Scientist (The [Hoosier] Naturalist). 1885–1891, Vols.1–5

Kansas Naturalist. 1902, one issue

Kansas Ornithological Society Bulletin [*originally* Reports]. 1950, Vol.1. . . .

Kentucky Ornithological Society, WPA Radio Programs, Nature Series. 1941

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ORNITHOLOGICAL LITERATURE

TRAVELS AND TRADITIONS OF WATERFOWL. By H. Albert Hochbaum. The University of Minnesota Press, Minneapolis, 1955: 6 4/5 x 10 in., x + 301 pp., 26 figs., 2 tables and numerous sketches. $5.00.

This is the best book on bird migration since Thompson's classic, "Problems of Bird-Migration," published 30 years ago. Although the title suggests that waterfowl are the sole subject of the book, the scope is broader. In fact, the text includes 145 species of birds, which embrace those observed as transients, those studied by other investigators which contribute to the author's thesis, and those studied intimately by the author.

The book is based largely upon observations of waterfowl and other birds in and around the Delta Waterfowl Research Station at the southern end of Lake Manitoba, Canada. In addition to material drawn from years of field observation, the author has used information from 495 papers to provide substance for his interpretation of waterfowl behavior and migration. The contents are presented in three parts: "Travels of Waterfowl," "Migrations of Waterfowl," and "Traditions of Waterfowl."

The background for an understanding of bird migration is developed in Part I. Hochbaum's thesis that birds, particularly waterfowl, orient themselves in flight by means of environmental cues, experience, and memory, is not new, but never before has it been set forth so lucidly and diligently. The author sets the pattern for waterfowl migration over vast distances by discussing the formation of flight trails about the Delta Marsh. There he observed that waterfowl used certain favored routes in flying from one part of the marsh to another. Young ducks, just awing, were believed to have learned these routes from experience in response to the pattern of water, marsh, and field.

Other factors forming a background for bird migration are discussed in chapters dealing with: "The Visual World," "The Function of Memory," "The Aerial Environment," and "Awareness of Time and Space." A most original and interesting series of experiments, made with hooded birds tossed upward into the air, is discussed. These experiments point up the ability of birds to remain aloft in flight even though the ground is invisible. Because the hooded birds failed to orient their flight with wind, unless it blew in strong gusts, it was deduced that migrants without visual contact with the earth could be displaced geographically without being aware of such displacement.

Part II deals with waterfowl in migration as described and evaluated under the following chapter titles: "The Cycle of Migration," "Flight Trails South," "Homeward Migration," "The Classification of Waterfowl Travel," "The Dimensions of Travel," "The Influence of Bad Weather," "Overseas Migration," "Magnetic and Radio Fields," and "Awareness of Direction."

Through these chapters the point is repeatedly made that waterfowl initiate migration under anticyclonic (high pressure) conditions with fair skies and favorable winds. This is not always the case. One of the largest migrations of waterfowl ever recorded in the Mississippi Flyway occurred on October 31-November 2, 1955, with cyclonic (low pressure) conditions which brought a heavy overcast and snow showers to a vast section of the flyway. Moreover, the exodus of large numbers of waterfowl from Illinois has frequently been associated with cyclonic conditions. It is apparent that the effect of anticyclonics and cyclonic conditions upon waterfowl migration need to be studied more fully.

Hochbaum, in summarizing a discussion of waterfowl orientation in migraton, reached this conclusion (p. 212): "The evidence at hand suggests that adult waterfowl travel as experienced birds over a familiar range. By reference to the sun, as to a compass, or to environmental patterns, like those presented by waves, they may hold a direct course for

some distance without visual reference to a familiar landscape. The studies of Matthews and Kramer (yet to be repeated with waterfowl) suggest that the sun may serve as the cue to the direction of home when the bird is displaced from familiar surroundings, but that such awareness hinges on the bird's distance from home."

Part III deals with the meaning of tradition in waterfowl behavior. The chaper titles are: "Biological Traditions," "Building New Traditions," "Traditional and Racial Isolation," and "Broken Traditions."

Both the author and the publisher deserve plaudits for the attractiveness of the book. Hochbaum's writing is colorful and pleasant to read; he is a most literate wildlife writer. In addition, his many excellent drawings portray the living marsh as well as various facets of waterfowl behavior. The paper is of good quality, the printing sharp and clear, and typographical errors negligible.—FRANK C. BELLROSE.

THE ART OF FALCONRY (DE ARTE VENANDI CUM AVIBUS). By Frederick II of Hohenstaufen. Translated and edited by Casey A. Wood and F. Marjorie Fyfe. Reprinted. Charles T. Branford Company, Boston, 1955: 8½ × 11 in., cxii–644 pp. 186 plates (two in color). $20.00.

Often referred to as "the noblest of arts," falconry was born in and emerged from the mists of remote antiquity. It was practiced by and was familiar to the peoples of China, ancient India, Assyria, Sumeria, and the other provinces of Babylonia, Egypt, and Persia thousands of years before Rome, the locale of this book, came into existence.

When the sport reached its climax in the West during the Middle Ages, Frederick II of Hohenstaufen (1194-1250), Holy Roman Emperor, King of Sicily and Jerusalem, became the most brilliant and most versatile exponent of the art of educating birds for the chase. But aside from the fact that he was an expert falconer, he was also an erudite ornithologist, well-informed forester, and an accomplished writer on all natural history subjects. Thus this volume becomes not only a complete manual of instruction on all phases of falconry (it is truly the "falconer's bible") but it takes its place as a scientific monograph of substantial value in ornithology.

Casey Albert Wood, member of the Wilson Ornithological Society from 1924 and elected member of the American Ornithologists' Union from 1921 until his death in 1942, spent his last ten years of work (in collaboration with his niece, F. Marjorie Fyfe) on a reproduction and translation of 'De Arte Venandi cum Avibus', chiefly at Rome and in the Vatican Library. There he made this and other translations from mediaeval Latin, and others from Arabic. That the translators did a magnificent job is evidenced by the prodigious and authoritative book, first appearing in 1943. It is unfortunate that Dr. Wood did not have the rare pleasure of seeing this final product of his monumental undertaking.

The original six books comprising Frederick's treatise on falconry were intended by him to be entirely scientific and general; hence he did not discuss many dramatic details, tell any hunting stories, or make many references to living men or places. They contain no effort to glamorize or romanticize the sport.

The translators adhere precisely to the text as Frederick wrote it, but they do clarify, through the use of copious footnotes, any items which may appear to be unidentifiable, obscure or ambiguous. For example, where the text reads: "In some white species of carrion eaters that have black feathers at the extremities of their wings, the saffron yellow of the mandibles extends to the middle of the head," the footnote explains: "This is the Egyptian carrion vulture (*Neophron percnopterus*)".

Generally there is a remarkable accuracy of the Emperor's descriptions but oversights or inconsistencies, where found, are pointed out. For instance, the text reads: "Certain land birds take their food on the wing, others on the ground. Some (for instance, swallows and siskins) devour their prey in the air." The footnote comments: "Why siskins (*sirone*) are associated (as examples of this habit) with swallows is strange, since the former rarely if ever act in this fashion." And some other intriguing references, which even the translators make no attempt to clarify, present a real challenge to the ornithologists of today.

Book One is an account of the structure and habits of birds with especially strong chapters on plumages, moults, and behaviour (these are invaluable to falconers who might also be serious-minded ornithologists) and migrations. Book Two covers the different kinds of falcons used in hunting, their care, manning, and equipment while Book Three refers to training aspects. Books Four, Five and Six set forth the rudiments of crane hunting with gyrfalcons, heron hawking with the saker falcon, and waterfowl hunting with the peregrine. There are several chapters of appended material, two of which covering the favorite birds of the chase and an annotated roster of birds probably well-known to the Emperor might be styled brief, incomplete, descriptive accounts of northern- and mid-European birds, with a sprinkling of the avifauna of the Near East and Far East.

The book warrants close inspection by all who are interested in any phase of bird study. It is fascinating reading and its excellent printing and illustrations invite an artistic appreciation of its informative contents. Its beauty and richness overcome and outweigh its bulkiness.—Burt L. Monroe, Sr.

Louisiana Birds. By George H. Lowery, Jr. Louisiana State University Press, 1955: 8¾ × 6⅝ in., xxxii + 556 pp., 40 plates (12 in full color) by Robert E. Tucker, 81 photographs, 147 figures in text. $5.00.

The stated purpose of this book is ". . . to introduce the people of Louisiana to the absorbing subject of ornithology." This purpose is reflected in the discussion in the early chapters of such topics as bird habitats in Louisiana; how to identify birds; feathers, plumages and molts; the bird skeleton; migration; the economic value of birds. Each of these chapters develops the topic adequately while being short enough to hold the interest of the non-technical reader. More detail is presented than is found in pocket-size field guides, although the species accounts which follow are brief in comparison to the treatment in conventional state bird books. In keeping with the approach, subspecies are omitted from the discussion.

The text throughout is very readable; while the personal element weights some accounts, it adds to the interest of the book. The account of the author's attempts at removal of English Sparrows should be read by everyone concerned with the control of any vertebrate species. Occasionally the author lapses into more technical language and uses a term the special meaning of which is not defined. One such instance is ". . . selection and defense of territories" on p. 71. At several points Dr. Lowery has taken the opportunity to explain the purposes of the serious student of ornithology; the chapter which discusses the activities of the Louisiana State Museum of Zoology is notable in this respect.

The drawings and paintings by Robert E. Tucker serve adequately as aids to identification, although in every case he has not captured the configurations or attitudes which are helpful in some groups. I feel that he has been most successful with the woodpeckers and finches.

The book has been produced handsomely, a condition which makes the price seem all the more remarkable. In addition to accomplishing his stated purpose, Dr. Lowery has written a book which will be useful to ornithologists beyond the borders of his state.—KEITH L. DIXON

INCUBATION PERIODS THROUGH THE AGES. By Margaret M. Nice. *Centaurus*, 3:311–359, 1954 (International Magazine of the History of Science. Copenhagen. This article printed in English.)

A search in the literature for the origin of erroneous incubation periods still being listed in recent publications took the author back 2300 years in recorded history. (Some evidence of the diligence of her search: 188 references cited and translations of several passages from German, French, Italian, Latin and Greek). The detective-like manner in which this quest was pursued provides a stimulating review, in brief, of the history of biology, particularly ornithology. Much of this material was presented in another article, (Nice, M. M. 1954. Problems of incubation periods in North American birds. *Condor*, 56:173–197)—the present paper emphasizing Old World aspects of the problem. A table of contents and numerous sub-headings make for easy reading. Occasional examples of man's weakness for a good story are offered for the same reason (but not with the same intent) and add a bit of salt. For example, a tale quoted in 1610 as "factual" describes a heat-of-friction method of incubation employed by certain gulls or skuas, these enterprising birds repeatedly dropping eggs from heights above the water until hatched by the heat obtained in falling through the air! Many errors in present-day incubation periods were found to be attributable to "copying of assumptions made by important people." Mrs. Nice concludes that there is need for a little skepticism and less blind reliance on authority—in short, more original investigation is in order.—ROBERT W. NERO.

LIFE HISTORIES OF CENTRAL AMERICAN BIRDS. Families Fringillidae, Thraupidae, Icteridae, Parulidae and Coerebidae. By Alexander F. Skutch. Cooper Ornithological Society, Berkeley, California; Pacific Coast Avifauna Number 31, 1954: 7 x 10 1/2 in., 448 pp., 68 figures, 1 color plate. Illustrated by Don Eckelberry. $10.00

With patience and a keen eye and ear an outstanding field biologist has produced with his fluent pen under expert editorship the most important information on the life cycle of any vertebrate group inhabiting Central America. Criticisms of the book would have to be largely in the nature of differences of opinion and sometimes of interpretation.

After a brief introduction to events leading to the production of this book and to a description of its scope and form, there begin the life histories of 41 species divided by families as follows: Fringillids, 9; tanagers, 13; icterids, 11; warblers, 5; honeycreepers, 3. Each account begins with a few paragraphs describing the species' obvious characteristics, often both generic and specific, its geographic and habitat distribution, and introductory glimpses into interesting and important behavior patterns. In some instances the reader must follow the author through descriptions which build to perfection the proper setting for the bird's activities. These descriptions are not out of place. Only a few readers will have been to Central America and would know about weather and status of vegetation on a Christmas Day which ". . . dawned clear and cloudless, with a brisk, chilling breeze driving down the valley . . . from the high summits of the Cordillera . . . The thickets . . . aglow with a profusion of white, yellow and red blossoms . . ."

Information included under each species is divided into various sections: food, anting,

voice, dominance, nest building, eggs, incubation, nestlings, subsequent broods, and others. For some species plumages and molts are described in considerable detail, including the approximate age of the individual at the time of the first molts and the appearance of the birds during the period of molt. One cannot, and I believe would not wish to, read only the material under certain section headings and expect to have a complete picture of that phase of the bird's habits. The information, taken almost entirely from the author's accumulated field notes, is for each species an informative and easily read account but it contains in one paragraph references to events which occurred over many years and fascinating digressions from the specific subject. These bring clarification of meaning and purpose to the point of discussion. Series of observations and synoptic material on nesting activities are presented in tabular form; but these are at a minimum and serve only to leave intact the story form and to permit clear examination of data for easy analysis. At the end of each species section is a summary; and at the end of each family section appears a summary of information on the family as a whole.

Throughout the book the reader is aware that here are included in meticulous detail discussions of avian ecology, behavior (some of it comparative behavior), and descriptions of the author's techniques in the field, the latter being in the reviewer's opinion of nearly equal importance to the data gathered on the subjects.

References to the literature indicate a thorough knowledge of the field on a world-wide basis; these are listed at the end of the book under "Literature Cited". The index is divided into two sections: the first, a list of common names of the birds; the second, a list of scientific names of birds to which reference is made. Each species is not treated in the same detail, and, of course, the knowledge of no species is complete. The gaps are clear, however, and will serve as focal points for future study.

The photographs are of great value and show careful consideration in choice. The color plate of the Golden-masked, Silver-throated, Blue, and Scarlet-rumped Black Tanagers is a highly pleasing frontispiece. Each of the other species included is illustrated admirably well in black and white by the pen and ink drawings of Don Eckelberry. Usually only a single bird is portrayed but three plumages are illustrated of the Variable Seed-eater, and both male and female of several other birds.

No ornithologist working with birds of the Western Hemisphere should be without access to this monumental work or to the other writings of Alexander Skutch.—DWAIN W. WARNER.

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Fenn M. Holden was awarded a degree in engineering by the University of Michigan in 1908, and he worked subsequently in the automobile business in the Detroit area. Following his retirement in the 1930's, he resumed a boyhood interest in bird watching. Mr. Holden, who spends his summers in Michigan and winters in Florida, has developed a keen interest in photographing birds. He is shown here using a 400 mm. lens.

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Monroe, Burt L(eavelle), Jr., Ridge Rd., Anchorage, Kentucky 1946
Monroe, Mrs. Robert A(nsley), 1424 Tugaloo Dr., S. W., Knoxville 19, Tenn. 1952
Monson, Gale, 1003 Ninth Ave., Yuma, Arizona 1933
Moore, Mrs. McBrayer, 335 W. Lexington St., Danville, Kentucky 1950
Moore, Milton C(yril), 501 Lincoln Ave., NW, Apt. 3, Canton 8, Ohio 1954
Moore, Robert B(yron), 1332 Knollwood Dr., Baton Rouge, Louisiana 1947
**Moore, Robert Thomas, Meadow Grove Place, Flintridge, Pasadena 2, Calif. 1939
Moran, James Vincent, 3822 Daves Pl., Apt. 302, Washington, D.C. 1943
Moreno, Abelardo, Museo Poey, Catedra "U", Escuela de Ciencias, University of Havana, Havana, Cuba 1949
Morrison, Kenneth Douglas, Mountain Lake Sanctuary, Lake Wales, Florida 1937
Morrow, Mrs. John, Jr., 1320 N. State St., Chicago 10, Illinois 1949
Morse, Douglas H., Star Route, Lisbon, Maine 1956
*Morse, Margarette Elthea, 122 W. South St., Viroqua, Wisconsin 1921
Mosby, Henry Sackett, 1300 Hillcrest Dr., Blacksburg, Virginia 1951
Mossman, H(arland) W(infield), 2902 Columbia Rd., Madison 5, Wisconsin 1948
*Muckley, Mrs. R. L., Apt. 9-A, 1335 Astor St., Chicago 10, Illinois 1950
*Mudge, Edmund W., Jr., 5926 Averill Way, Dallas, Texas 1939
*Mueller, Mrs. Florence N., 4408 Pine St., Omaha 5, Nebraska 1951
Mueller, Helmut Charles, 2756 N. Palmer St., Milwaukee 12, Wisconsin 1949
Muhlbach, W(alt) L(auritz), 2127 Ashby Ave., Berkeley 5, California 1951
Mumford, Russell E(ugene), Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1949
Munter, Rear Admiral W(illiam) H(enry), 4518-52nd Ave., NE, Seattle 5, Washington 1933
Murie, Adolph, Moose, Wyoming 1932
Murie, O(laus) J(ohan), Moose, Wyoming 1934
Murphy, Paul C(harles), 935 Goodrich Ave., Apt. 10, St. Paul 5, Minnesota 1944
Murray, Bertram George, Jr., 807 Mountain Ave., Bound Brook, New Jersey 1954
Murray, Rev. J(oseph) J(ames), 6 White Street, Lexington, Virginia 1931
Murray, Lucy H(unter), Regina College, Regina, Saskatchewan, Canada 1954
Musselman, T(homas) E(dgar), 124 South 24th St., Quincy, Illinois 1940
Myers, Buford M(acMartin), Jr., 2104 Gen. Pershing St., New Orleans 15,

Louisiana 1948
Myers, Richard F., 31 "R" St., Columbia, Missouri 1952
Neal, Mrs. Charles, Box 133, Demorest, Georgia 1946
Neff, Johnson Andrew, Bldg. 45, Denver Federal Center, Denver 2, Colorado 1920
Nelson, Charles E(llsworth), Jr., 124 Oxford Rd., Waukesha, Wisconsin 1937
Nelson, Gid E(dmund), Jr., Alabama College, Montevallo, Alabama 1953
**Nelson, Theodora, 315 East 68th St., New York 21, New York 1928
Nero, Robert William, Saskatchewan Museum of Natural History, Regina, Saskatchewan, Canada 1947
*Ness, Robert David, 17 Five Points Rd., Rush, New York 1951
Nessle, James P., R.F.D. 1, Waterville, Ohio 1936
Nesslinger, Carlita L., 103 Caldwell Rd., Forest Home, Ithaca, New York 1956
*Netting, M(orris) Graham, Carnegie Museum, Pittsburgh 13, Pennsylvania 1941
Nevius, Mrs. Richard, R. #1, Greeneville, Tennessee 1940
New, John G., Science Dept., St. Univ. Teachers College, Oneonta, New York 1946
Newberry, A(ndrew) Todd, 70 Rock Spring Rd., West Orange, New Jersey 1952
Newman, Robert J(ames), 312 West Roosevelt St., Baton Rouge, Louisiana 1950
Ney, William O., Jr., 608 W. Broadway, Ponca City, Oklahoma 1955
Nice, L(eonard) B., 5725 Harper Ave., Chicago 37, Illinois 1932
**Nice, Mrs. Margaret Morse, 5725 Harper Ave., Chicago 37, Illinois 1921
*Nichols, Charles K(etcham), 212 Hamilton Rd., Ridgewood, New Jersey 1933
*Nichols, John Treadwell, American Museum of Natural History, 79th St. & Central Park W., New York 24, New York 1941
Nicholson, Donald J(ohn), 1224 Palmer St., Orlando, Florida 1945
*Nickell, Walter Prine, Cranbrook Institute of Science, Bloomfield Hills, Mich. 1943
*Nielsen, Mrs. B. W., Route #1, Box 808, Kauffman Ave., Red Bluff, California 1945
Nielsen, Joseph A(ustin), 253 Warren St., Brooklyn 2, New York 1954
Nighswonger, Paul F., Route 9, Alva, Oklahoma 1950
Nolan, James R., 14 Edgewood Rd., Peekskill, New York 1954
Nolan, Val, Jr., Indiana University School of Law, Bloomington, Indiana 1953
Noland, Mrs. Hulbert V., 57 Indian Hills Trail, Louisville 7, Kentucky 1956
Nordquist, Theodore C., 2701 York Ave., N., Robbinsdale 22, Minnesota 1941
Nork, Theodore J., 451 Wrightwood Ave., Chicago 14, Illinois 1947
Norman, Edward d'Aubigny, 181 Stage Harbor Rd., Chatham, Massachusetts 1951
Norman, James L(ee), 2617 Elgin, Muskogee, Oklahoma 1948
Norris, Robert Allen, 1918 Hahn Avenue, Aiken, South Carolina 1941
Norse, William J., 531 W. 211th St., New York 34, New York 1939
North, George W(ebster), 249 Charlton Ave., Hamilton, Ontario, Canada 1941
Northrop, Mrs. Harson A., 358 East Main St., Owatonna, Minnesota 1952
Northrop, Myron, 9304 Sylvan Hills Rd., North Little Rock, Arkansas 1945
Novaes, Fernando (da) C(osta), Museu Pareanse, Emilio Goeldi, Belem, Para, Brazil 1953
**Nowland, Paul J., 700 Equitable Bldg., Wilmington, Delaware 1950
Nyc, Frederick F., Jr., P.O. Box 451, McAllen, Texas 1943
Oberholser, Harry Church, 2933 Berkshire Rd., Cleveland Heights, Cleveland 18, Ohio 1894
O'Callaghan, Terence C., Maromala R. D., Bay of Islands, Northland, New Zealand 1954
*Odum, Eugene P(leasants), Dept. of Zoology, University of Georgia, Athens, Georgia 1930
Oeming, Albert F., Sub. P. O. 23, Edmonton, Alberta, Canada 1956
Ogden, E. Gordon, Box 1045, Alfred, New York 1956
Ogilvie, Phillip W., Museum of Natural History, University of Kansas, Lawrence, Kansas 1956
Olds, Betty L., 1144 Lafayette SE, Grand Rapids 7, Michigan 1956
*Olsen, Dr. Richard E., 3325 Franklin Rd., Route 3, Bloomfield Hills, Michigan 1938
*Olson, Mrs. Simon, 33 Harvard Dr., Lake Worth, Florida 1942
Olson, Mrs. Monrad J., Box 595, Watford City, North Dakota 1946
O'Neil, Norah Selby, 1311 Bonham St., Commerce, Texas 1949
*O'Reilly, Ralph A., Jr., Box 132, Davisburg, Michigan 1936

Orians, Rev. Howard L(ester), 2209 Hollister Ave., Madison 5, Wisconsin 1947
Ott, Frederick L(ouis), 1358 N. 63rd St., Wauwatosa 13, Wisconsin 1941
Overing, Robert, R.D. #4, Raleigh, North Carolina 1930
Owen, Oliver S., 333 N. 14th St., Milwaukee, Wisconsin 1956
Owre, Oscar T., Dept. of Zoology, University of Miami, Coral Gables, Florida 1935
Packard, Christopher M., Portland Museum of Natural History, 22 Elm St., Portland, Maine 1951
Packard, Fred Mallory, 24 Elizabeth Lane, R.D. #2, Fairfax, Virginia 1949
Packard, Robert Lewis, Museum of Natural History, Lawrence, Kansas 1954
Paine, Robert T(reat), III, 2 Hubbard Park, Cambridge 38, Massachusetts 1951
Palmer, Ralph S(imon), New York State Museum, State Education Bldg., Albany 1, New York 1934
*Palmquist, Clarence O(scar), 834 Windsor Rd., Glenview, Illinois 1945
Pangborn, Mark W(hite), 25 E. 56th St., Indianapolis, Indiana 1948
*Parkes, Kenneth Carroll, Carnegie Museum, Pittsburgh 13, Pennsylvania 1946
Parks, Richard Anthony, 2303 Pembrook Place, NE, Atlanta, Georgia 1942
Parmelee, David F(reeland), 533 Harding, Iron Mountain, Michigan 1949
Partridge, William H., Belgrano 363, Caseros F. C. S. M., Buenos Aires, Argentina, S. A. 1953
Patten, Bradley M., 2126 Highland Rd., Ann Arbor, Michigan 1953
Payne, Rinda Mary, Box 320, Route #4, Portland, Maine 1956
Paynter, R(aymond) A(ndrew), Jr., Museum of Comparative Zoology, Harvard University, Cambridge 38, Massachusetts 1946
*Pearson, Mrs. Carl E., 632 N. Stone Ave., LaGrange Park, Illinois 1954
Peelle, Miles L., 1039 College St., Adrian, Michigan 1940
Peffer, Mrs. Thomas A., 49 West Depot St., Hellertown, Pennsylvania 1954
Penner, Lawrence R., Dept. of Zoology & Entomology, University of Connecticut, Storrs, Connecticut 1940
Perkins, Mrs. Mary Loomis, 1305 S. 52nd St., Omaha 6, Nebraska 1946
Peterle, Tony J(ohn), Rose Lake Wildlife Exp. Station, East Lansing, Michigan 1951
Peters, Arthur L(illibridge), 325 South Fourth St., Delavan, Wisconsin 1954
Peters, Harold S(eymour), 968 Cumberland Rd., NE, Atlanta 6, Georgia 1924
Peters, Stuart S., Dept. of Mines & Resources, St. Johns, Newfoundland 1952
Petersen, Arnold J(erome), 712 W. Third St., Northfield, Minnesota 1949
Petersen, Peter C., 620 E. 30th St., Davenport, Iowa 1951
Peterson, Alfred, Box 201, Brandt, South Dakota 1931
Peterson, Mrs. C(harles) E(mil), Madison, Minnesota 1936
**Peterson, Roger Tory, Neck Rd., Old Lyme, Connecticut 1942
Petroskey, Helen Martha, Box 7, Hiram, Ohio 1949
**Pettengill, Olin Sewall, Jr., Wayne, Maine 1930
Pettit, Lincoln C(oles), Box 217, Hiram, Ohio 1948
Peugh, Marguerite M(ary), Apartado 16, Montemorelos, Nuevo Leon, Mexico 1951
**Phelps, William H(enry), Apartado 2009, Caracas, Venezuela, S. A. 1940
**Phillips, Allan Robert, 113 Olive Rd., Tucson, Arizona 1934
*Phillips, Homer Wayne, 2110 Morse St., Houston 19, Texas 1947
Phillips, Richard S(tuart), 834 Liberty St., Findlay, Ohio 1944
Phillips, William B(utterworth), 166 E. 96th St., New York 28, New York 1951
Pielou, William P(ercival), 1549 Ann St., East Lansing, Michigan 1954
*Pieratt, J(ames) F(rancis), 809 West Otoe, Ponca City, Oklahoma 1953
Pierce, Fred J(ohn), Winthrop, Iowa 1947
*Pierce, Robert Allen, 1222 - 80th St., West Des Moines, Iowa 1941
*Pirnie, Miles David, Conservation Bldg., Michigan State University, East Lansing, Michigan 1928
Pittman, James Allen, Jr., 12 West Dr., Bethesda 14, Maryland 1945
Plath, Karl, 114 S. East Ave., Oak Park, Illinois 1942
*Poole, Cecil A(very), 1764 Topeka Ave., San Jose 26, California 1942
*Poor, Hustace Hubbard, 7 Colonial Court, New Canaan, Connecticut 1935
*Porter, Dr. Eliot F(urness), Route 1, Box 33, Santa Fe, New Mexico 1947
Porter, Richard Dee, Dept. of Wildlife Mgmt., Texas A&M College, College Station, Texas 1950

Porter, T(homas) Wayne, Dept. of Zoology, Michigan State University, East Lansing, Michigan 1938
Potter, Mrs. Allen V., 1916 Norvell Rd., R.D. #1, Grass Lake, Michigan 1956
Potter, David M., 1557 Timothy Dwight College, Yale University, New Haven 11, Connecticut 1946
*Potter, Mrs. George C., 2111 Malvern Rd., Charlotte 7, North Carolina 1948
Potter, Julian K(ent), 437 Park Ave., Collingswood 7, New Jersey 1915
Potter, Louis Henry, R.D. #1, West Rutland, Vermont 1941
**Pough, Richard H(ooper), 33 Highbrook Ave., Pelham 65, New York 1938
Praemassing, Eugenia M., 87 Linden Ave., Buffalo 14, New York 1956
Praemassing, Kathryn M., 87 Linden Ave., Buffalo 14, New York 1956
*Prather, Millard F(illmore), P. O. Box 599, Fairfield, Alabama 1910
Prescott, Kenneth Wade, Kansas City Museum, 3218 Gladstone Blvd., Kansas City, Missouri 1946
Preston, Frank W(illiam), Box 149, Butler, Pennsylvania 1948
Prior, Gertrude, Sweet Briar, Virginia 1956
Prosser, Capt. Albert L(aurence), Box H, 116 Main Street, Springvale, Maine 1955
Prucha, Alma H., 1716 N. Prospect Ave., Milwaukee 2, Wisconsin 1942
Pruitt, Mrs. William O., Jr., Arctic Aeromedical Laboratory, Ladd Air Force Base, Fairbanks, Alaska 1948
Puett, May Wilson, P. O. Box 2183, Greenville, South Carolina 1950
Puleston, Dennis, Brookhaven National Laboratory, Upton, New York 1955
Pusey, Catherine, 921 N. Anthony Blvd., Fort Wayne 3, Indiana 1953
*Putman, William L(loyd), Dominion Entomological Laboratories, Vineland Station, Ontario, Canada 1945
Putnam, Mrs. Evelyn J., 1407 Woodland Ave., Duluth, Minnesota 1951
Putnam, Loren Smith, Dept. of Zoology, Ohio State University, Columbus 10, Ohio 1942
Quam, Mrs. Mary Battell, 102 Cedar Hollow Rd., Paoli, Pennsylvania 1944
*Quay, Thomas L., Zoology Dept., North Carolina State College, Raleigh, North Carolina 1939
Quay, W(ilbur) B(rooks), Dept. of Zoology, University of California, Berkeley 4, California 1949
Quilliam, Mrs. H(elen) R(ose), R.R. #1, Kingston, Ontario, Canada 1953
Quimby, Don C., Dept. of Zoology & Entomology, Montana State College, Bozeman, Montana 1942
*Ragusin, Anthony V(incent), P.O. Box 496, Biloxi, Mississippi 1937
Rahe, Carl W., 9005 Tioga Ave., Cleveland 5, Ohio 1931
Ramisch, Marjorie V(iola), Book Repair, 1027 Hamilton Ave., Cleveland 14, Ohio 1943
Ramsay, A(lfred) Ogden, McDonogh School, McDonogh, Maryland 1949
Rand, Austin L., Chicago Natural History Museum, Roosevelt Rd. & Lake Shore Dr., Chicago 5, Illinois 1950
Randall, Clarence B(elden), 38 S. Dearborn St., Chicago, Illinois 1949
Randall, Robert Neal, 928 - 16th St., Bismarck, North Dakota 1939
Randle, Worth S., 5332 Hollywood Blvd., Los Angeles 27, California 1949
Rapp, William F(rederick), Jr., 430 Ivy Ave., Crete, Nebraska 1941
Raymond, Richard C., 29 Overhill Rd., Scarsdale, New York 1953
Rea, Gene, 251 Leland Ave., Columbus 2, Ohio 1948
Read, Bayard W(hitney), Upper Dogwood Lane, Rye, New York 1949
*Rebmann, G. Ruhland, Jr., 729 Millbrook Lane, Haverford, Pennsylvania 1941
Reed, Parker Crosby, 27 Hayes Ave., Lexington, Massachusetts 1949
Reeder, Clara Maude, 1608 College Ave., Houghton, Michigan 1938
Rees, Dr. Earl Douglas, 1504 North Main St., Findley, Ohio 1946
Reese, C(arl) R(ichard), 266 East Dunedin Rd., Columbus 14, Ohio 1948
Reese, Mrs. Hans H., 3421 Circle Close, Shorewood Hills, Madison, Wisconsin 1941
*Rehfisch, Carol, 335 Delgado, Santa Fe, New Mexico 1949
Reichert, Elsa, Mirakel Repair Company, 14 West First St., Mt. Vernon, N. Y. 1950
Reilly, E(dgar) M(ilton), Jr., R.D., Old Chatham, New York 1946
Renfrew, Mrs. Malcolm M., 104 Saratoga Rd., Buffalo 21, New York 1956

Rett, Egmont Z(achary), Museum of Natural History, Santa Barbara, Calif. 1940
Reuss, Alfred Henry, 2908 Edison St., Blue Island, Illinois 1936
Reynard, George B., 728 Parry Ave., Palmyra, New Jersey 1950
Reynolds, Mrs. L. Bruce, 4020 South Toledo, Tulsa 5, Oklahoma 1955
Reynolds, William Pius, 1330 Foulkrod St., Philadelphia 24, Pennsylvania 1948
Rice, Dale W(arren), U.S. Fish & Wildlife Service, Bldg. 45, Denver Federal Center, Denver, Colorado 1946
Rice, Orville O(wen), 1663 West 28th St. Terrace, Topeka, Kansas 1953
Rich, Mrs. Eva, 150 W. 80th St., New York 24, New York 1952
Richards, Tudor, Hurricane Rd., Keene, New Hampshire 1951
*Richardson, Dr. E(dgar) P(reston), 734 Glynn Court, Detroit 2, Michigan 1954
Richdale, Lancelot Eric, 23 Skibo St., Kew, Dunedin SW 1, New Zealand 1945
Richter, Carl H., 703 Main St., Oconto, Wisconsin 1947
Richter, Dr. G(eorge) William, 231 E. Main St., Canfield, Ohio 1954
Ricker, W(illiam) E(dwin), Pacific Biological Station, Nanaimo, British Columbia, Canada 1943
Riesz, Richard P(arrish), 114 Franklin St., Apt. 5-A 2, Morristown, New Jersey 1955
Riggs, Carl D(aniel), Dept. of Zoology, University of Oklahoma, Norman, Oklahoma 1943
Riggs, Jennie, 3313 Fairmont Drive, Nashville 5, Tennessee 1952
Rimsky-Korsakoff, V(ladimir) N(icholas), 220 Middle Rd., Sayville, L. I., New York 1951
Ripley, S(idney) Dillon, II, Peabody Museum, New Haven 11, Connecticut 1946
Rising, Gerald R(ichard), 72 Allen's Creek Rd., Rochester 18, New York 1953
Rising, James D., 4406 Sunrise Dr., Kansas City, Missouri 1956
*Ritchie, Dr. Robert C., Mansfield Farms, R.R. #2, King, Ontario, Canada 1942
**Robbins, Chandler S(eymour), Patuxent Research Refuge, Laurel, Maryland 1941
**Robbins, Eleanor C(ooley), Patuxent Research Refuge, Laurel, Maryland 1936
Roberts, Harold D., 610 Harrison St., Black River Falls, Wisconsin 1946
Roberts, Neddie O'Moore, 915 Boyd Ave., Baton Rouge, Louisiana 1956
Robertson, Mary J., R.D. 2, Box 83c, Homestead, Florida 1954
Robins, C(harles) Richard, 3300 N. Third St., Harrisburg, Pennsylvania 1949
Robinson, Peter J., 333 Crossman St., Jamestown, New York 1956
Robinson, Thane S., Museum of Natural History, University of Kansas, Lawrence, Kansas 1952
Rocheleau, David H., 131 Benton St., Cheboygan, Michigan 1954
Roe, John F., Pride, Louisiana 1956
Roesler, Mrs. M. Stuart, June Rd., Cos Cob, Connecticut 1949
Roesler, M. Stuart, June Rd., Cos Cob, Connecticut 1949
**Rogers, Charles Henry, East Guyot Hall, Princeton, New Jersey 1903
Rogers, John P., Wildlife Bldg., University of Missouri, Columbia, Missouri 1956
Rogers, Major Gerald T., 543 N. Beachview Dr., Fort Walton Beach, Florida 1956
Rogers, K(ay) T(rowbridge), Dept. of Zoology, Oberlin College, Oberlin, Ohio 1952
**Rogers, Mabel T., 436 N. Beach St., W., Daytona Beach, Florida 1947
*Rogers, Mrs. Walter E., 911 E. North St., Appleton, Wisconsin 1931
Rooney, James P., 1514 South 12th Ave., Yakima, Washington 1947
**Root, Oscar M(itchell), Brooks School, North Andover, Massachusetts 1940
Root, Richard Bruce, 265 Ann St., Plymouth, Michigan 1953
Rorimer, Mrs. J. M., 6910 Point of Rocks Rd., Sarasota, Florida 1938
Rosche, Richard Carl, 48 Dartmouth Ave., Buffalo 15, New York 1953
Rose, W(illiam) C(umming), 710 W. Florida Ave., Urbana, Illinois 1949
Rosewall, O(scar) W(aldemar), Dept. of Zoology, Louisiana State University, Baton Rouge 3, Louisiana 1931
Rositzky, Simon, 1605 Ashland Blvd., St. Joseph, Missouri 1953
*Ross, C(harles) Chandler), 710 Wolcott Drive, Philadelphia 18, Pennsylvania 1937
Ross, Hollis T., 29 South 2nd St., Lewisburg, Pennsylvania 1956
Ross, James B., 2408 Westminster Way, NE, Atlanta 7, Georgia 1949
**Ross, Mrs. Mary R(eeve) Spear, 455 E. Ridge St., Marquette, Michigan 1953
**Rudd, Dr. Clayton G(lass), 315 Medical Arts Bldg., Minneapolis 2, Minnesota 1944
Ruder, Clara Louise, 520 Franklin St., Wausau, Wisconsin 1954

Ruettger, Mrs. Ruby T., 3011 SW 19th Terr., Miami 45, Florida 1954
Ruhland, Mary Lou, 216 N. State St., Apt. 5, Ann Arbor, Michigan 1956
Russell, Stephen M(ims), 267 East Valley, Abingdon, Virginia 1952
Rutter, Russell James, Box 794, Huntsville, Ontario, Canada 1950
Ryder, Ronald A., c/o Utah Coop. Wildlife Research Unit, Utah State Agricultural College, Logan, Utah 1952
Ryel, Lawrence A(twell), Ogenaw State Game Refuge, St. Helen, Michigan 1951
Sabin, Walton B., 652 Kenwood Ave., Slingerlands, New York 1945
Samson, Dale D(umont), 613 Carrolton Blvd., West Lafayette, Indiana 1951
Sanborn, Alvah W., Pleasant Valley Sanctuary, Lenox, Massachusetts 1951
Sandy, Tirzah M., University Hospital, Redwood & Greene Sts., Baltimore 1, Maryland 1950
Sather, John Henry, Western Illinois State College, Macomb, Illinois 1956
Satter, John M., 4500 Millersville Rd., Indianapolis 5, Indiana 1955
Satterly, J(ack), 100 Castlewood Rd., Toronto 12, Ontario, Canada 1947
Sauer, Gordon C(henoweth), 425 E. 63rd St., Kansas City 10, Missouri 1949
Saugsted, N(els) Stanley, R.D. 4, Minot, North Dakota 1939
*Saunders, Aretas A(ndrews), Box 141, Canaan, Connecticut 1934
Saunders, George B(radford), Fish & Wildlife Service — 623 Peachtree, Seventh Bldg., Atlanta 23, Georgia 1926
**Savage, James, Buffalo Athletic Club, Buffalo, New York 1939
*Savery, Don(ald) B(rooks), 8630 Chilson Rd., Brighton, Michigan 1953
Sawyer, Dorothy, 500 Orwood Place, Syracuse 8, New York 1937
Schaich, Charles A., 1301 Walnut St., Reading, Pennsylvania 1951
*Scheidel, Mrs. Bessie M., 94 Wetzel Rd., Pittsburgh 9, Pennsylvania 1956
Schley, Mrs. F. B., 1352 Peacock Ave., Columbus, Georgia 1952
Schlonga, A(ndrew) M(atthew), 511 Thornton St., Leavenworth, Kansas 1952
Schneider, Evelyn J., 2207 Alta Ave., Louisville 5, Kentucky 1935
Schnell, Jay H(eist), 1696 Paper Mill Rd., Meadowbrook, Pennsylvania 1953
**Schnitzer, Albert, 922 Lakeside Place, Elizabeth 3, New Jersey 1953
Schoenbauer, Clara K., 5319 Greenway Dr., Hyattsville, Maryland 1952
**Schorger, A(rlie) W(illiam), 168 N. Prospect Ave., Madison, Wisconsin 1927
**Schultz, Albert B(igelow), Jr., 1117 Broadway, Hewlett, New York 1954
Schumm, William George, 302 C St., LaPorte, Indiana 1944
Schuster, Evelyn E., 111 N. Houghton Ave., Manistique, Michigan 1953
Schwab, Larry T(idd), 169 Main St., Kingwood, West Virginia 1953
Schwartz, Charles Walsh, 131 Forest Hill, Jefferson City, Missouri 1950
*Schwartz, Paul A(lvin), Apartado 1766, Caracas, Venezuela, S. A. 1952
Schwilling, Marvin D., Box 62, Pleasanton, Kansas 1951
Sciple, George W., P.O. Box 1095, Emory University, Georgia 1951
Scotland, Minnie B(rink), 42 Continental Ave., Cohoes, New York 1938
Scott, D. M., Dept. of Zoology, University of Western Ontario, London, Ontario, Canada 1950
Scott, Frederic R(obert), 115 Kennodale Lane, Richmond 26, Virginia 1947
*Scott, Peter, The New Grounds, Slimbridge, Gloucestershire, England 1947
Scott, Thomas G(eorge), Section of Game Research and Management, Illinois Natural History Survey, Urbana, Illinois 1936
Scott, W(alter) E(dwin), 1721 Hickory Dr., Madison 5, Wisconsin 1938
Seaman, George Albert, P.O. Box 472, Christiansted, St. Croix, Virgin Islands 1950
Seeber, Edward L(incoln), 213 Columbia St., Ithaca, New York 1944
Seibert, Henri C., Ohio University, Athens, Ohio 1941
Seibert, Robert F(rederick), 17 Canoe Brook Rd., Short Hills, New Jersey 1954
Seiter, Floyd B., 59124 Main St., Box 113, New Haven, Michigan 1956
Serbousek, Lillian, 1226 Second St. SW, Cedar Rapids, Iowa 1935
Shackleton, Mrs. Walter H., Route 1, Box 76 A, Prospect, Kentucky 1947
Shackleton, Walter H., Route 1, Box 76 A, Prospect, Kentucky 1947
Shaftesbury, Archie D., Women's College, University of North Carolina, Greensboro, North Carolina 1930
Shannon, Mrs. Francis P., 3021 Eagle Pass, Louisville, Kentucky 1949
Sharp, Ward M., 206 Forestry Bldg., Penn. State University, University Park,

Pennsylvania 1936
Shaub, Benjamin Martin, 159 Elm St., Northampton, Massachusetts 1948
Shaver, Jesse M(ilton), 1706 Linden Ave., Nashville 12, Tennessee 1922
*Shearer, Dr. A(mon) R(obert), Box 428, Mont Belvieu, Chambers County, Texas 1893
*Sheffield, O(ren) C(onway), 817 West Houston, Tyler, Texas 1954
**Sheffler, W(illiam) J(ames), 4731 Angeles Vista Blvd., Los Angeles 43, Calif. 1954
Shellenberger, Emmett L(ee), Akron Museum of Natural History, 500 Edgewood Ave., Akron 7, Ohio 1954
Shetler, Stanwyn G(erald), Dept. of Botany, Cornell University, Ithaca, N. Y. 1949
*Shires, James E., 3902nd Support Sq., Offutt AFB, Nebraska 1951
Shobo, Maruto, 334, 42 Nakagomon-cho, Nishinokyo, Nakakyo-Ku, Kyoto, Japan 1956
Short, Wayne, 1130 Fifth Ave., New York 28, New York 1941
Shuler, James B(ernard), Jr., 43 Kirkwood Lane, Greenville, South Carolina 1954
Sibley, Charles G(ald), Fernow Hall, Cornell University, Ithaca, New York 1942
Sibley, Fred C(harles), R.D. #1, Alpine, New York 1953
Sick, Dr. Helmut M., Avenida Nilo Pecanha 23 III, Rio de Janeiro, D. F., Brazil 1951
Sieh, James G(erald), Biology Bldg., Okoboji, Iowa 1948
*Simmons, Mrs. Amelia C., 2742 N. Maryland Ave., Milwaukee 11, Wisconsin 1943
**Simmons, Edward McIlhenny, Avery Island, Louisiana 1942
**Simmons, Grant Gilbert, Jr., Lake Ave., Greenwich, Connecticut 1949
Simon, Stephen Wistar, Blue Mount Rd., Monkton, Maryland 1947
Singleton, Albert Roland, 3968 Marburg Ave., Cincinnati 9, Ohio 1948
Siverling, Mrs. Signa I., Bowbells, North Dakota 1952
Sjodahl, Sven Erik, 7013 Noble Ave., Cincinnati 24, Ohio 1949
Skelton, Mrs. Kathleen Green, Middleton, Delaware 1949
Skutch, Alexander F(rank), San Isidro del General, Costa Rica 1944
Slack, Mabel, 1004 Everett Ave., Louisville 4, Kentucky 1934
*Smith, Allen G(ordon), Box 603, Brigham City, Utah 1949
Smith, Alta, P.O. Box 516, 516 Cedar Ave., Lakeside, Ohio 1956
Smith, Dr. A(rthur) F(rancis), 621 Third St., Manning, Iowa 1934
Smith, Bess M(ay), P.O. Box 337, Arcadia, Oklahoma 1955
*Smith, Emily D., 19651 Glen Una Dr., Los Gatos, California 1948
*Smith, Harry M(adison), 1602 State St., Columbus, Indiana 1936
Smith, Marion L(ucille), 429 S. Willard St., Burlington, Vermont 1949
Smith, Orion O., 2911 Springcreek, Rockford, Illinois 1936
Smith, Rhoda N., Route #1, Box 85, Ontonagon, Michigan 1956
Smith, Robert L(eo), Route #1, Reynoldsville, Pennsylvania 1945
*Smith, Roy Harmon, 883 Bryce Rd., Kent, Ohio 1936
Smith, Sara L., High School, Forbus St., Poughkeepsie, New York 1956
Smith, Thomas Price, Woolridge Ave., Pewee Valley, Kentucky 1951
Smith, Wendell Phillips, Kensington Ave., North Wilkesboro, North Carolina 1921
Snapp, Mrs. R. R., 310 W. Michigan, Urbana, Illinois 1940
Snead, Mrs. Idalene F., 845 South 42nd St., Birmingham 6, Alabama 1956
Snow, Mrs. C. S., 2211 Chester Blvd., Richmond, Indiana 1950
Snyder, Dana Paul, Dept. of Zoology, University of Massachusetts, Amherst, Massachusetts 1949
*Snyder, Dorothy E(astman), 452 Lafayette St., Salem, Massachusetts 1951
Snyder, L(ester) L(ynne), Royal Ontario Museum of Zoology, Queen's Park at Bloor St., Toronto 5, Ontario, Canada 1929
Sommers, Roderic W., 38 Franklin St., Medford 55, Massachusetts 1956
Sooter, Clarence Andrew, U.S. Public Health Service, P.O. Box 625, Greeley, Colorado 1940
**Sorrill, Mrs. Anna Marie, 1501 Kentucky St., Quincy, Illinois 1950
Southern, William, 513 E. Brook, Norman, Oklahoma 1954
Spangler, Iva M., 128 E. Foster Parkway, Fort Wayne, Indiana 1939
Sparkes, Vera E., 2417 Lyndale Ave., N., Minneapolis 11, Minnesota 1951
Speirs, Mrs. Doris Huestis, "Cobble Hill," R.D. #2, Pickering, Ontario, Canada 1936
Speirs, J(ohn) Murray, "Cobble Hill," R.D. #2, Pickering, Ontario, Canada 1931

**Spencer, Haven Hadley, 2645 Bedford Rd., Ann Arbor, Michigan 1946
**Spencer, O(live) Ruth, 1030-25th Ave. Court, Moline, Illinois 1938
*Sperry, Charles Carlisle, 1455 S. Franklin St., Denver 10, Colorado 1931
Spofford, Walter R(ichardson), II, Dept. of Anatomy, Syracuse Medical College, Syracuse 10, New York 1942
Stabler, Robert M(iller), Colorado College, Colorado Springs, Colorado 1939
Staebler, Arthur E(ugene), Biology Department, Fresno State College, Fresno, California 1937
Stahl, Marjoretta Jean, Kimberly, West Virginia 1942
Stallcup, William B., Biology Dept., Southern Methodist University, Dallas, Texas 1951
Stamm, Mrs. Frederick W., 2118 Lakeside Dr., Louisville 5, Kentucky 1947
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Zoological Record, Aves (reviewed) 167

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SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (fourth edition) and supplements thereto insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. The Illustrations Committee will prepare drawings, following authors' directions, at a charge of $1 an hour, the money to go into the color-plate fund. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A WORD TO MEMBERS

The Wilson Bulletin is not as large as we want it to be. It will become larger as funds for publication increase. The Society loses money, and the size of the *Bulletin* is cut down accordingly, each time a member fails to pay dues and is put on the 'suspended list.' Postage is used in notifying the publisher of this suspension. More postage is used in notifying the member and urging him to pay his dues. When he does finally pay he must be reinstated on the mailing list and there is a publisher's charge for this service. The Bulletin will become larger if members will make a point of paying their dues promptly.

NOTICE OF CHANGE OF ADDRESS

If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia. He in turn will notify the publisher and editor.

Your 1957 vacation plans should include

THE THIRTY-EIGHTH ANNUAL MEETING

which will convene on the campus of

THE UNIVERSITY OF MINNESOTA, DULUTH BRANCH

DULUTH, MINNESOTA

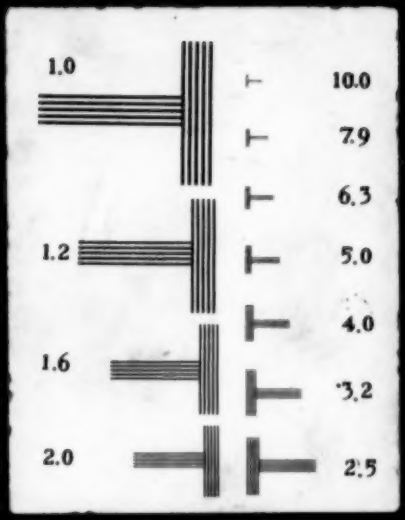
June 13–16

Sponsors:

Minnesota Ornithologists Union
University of Minnesota, Duluth Branch
Duluth Bird Club

In 1958, the Society visits Oglebay Park, Wheeling,
West Virginia, from April 24–27

RESOLUTION CHART



100 MILLIMETERS

INSTRUCTIONS Resolution is expressed in terms of the lines per millimeter recorded by a particular film under specified conditions. Numerals in chart indicate the number of lines per millimeter in adjacent "T-shaped" groupings.

In microfilming, it is necessary to determine the reduction ratio and multiply the number of lines in the chart by this value to find the number of lines recorded by the film. As an aid in determining the reduction ratio, the line above is 100 millimeters in length. Measuring this line in the film image and dividing the length into 100 gives the reduction ratio. Example: the line is 20 mm. long in the film image, and $100/20 = 5$.

Examine "T-shaped" line groupings in the film with microscope, and note the number adjacent to finest lines recorded sharply and distinctly. Multiply this number by the reduction factor to obtain resolving power in lines per millimeter. Example: 7.9 group of lines is clearly recorded while lines in the 10.0 group are not distinctly separated. Reduction ratio is 5, and $7.9 \times 5 = 39.5$ lines per millimeter recorded satisfactorily. $10.0 \times 5 = 50$ lines per millimeter which are not recorded satisfactorily. Under the particular conditions, maximum resolution is between 39.5 and 50 lines per millimeter.

Resolution, as measured on the film, is a test of the entire photographic system, including lens, exposure, processing, and other factors. These rarely utilize maximum resolution of the film. Vibrations during exposure, lack of critical focus, and exposures yielding very dense negatives are to be avoided.